POWER

Volume 55 New York, January 31, 1922 *Number* 5

Graft

ONCE I offered an engineer a cigar. I have done such things at other times, but this particular time I was met by a curt refusal.

It was not that this engineer did not smoke or that smoking was not allowed on his premises, for he rather ostentatiously pulled a cigar out of his own pocket and lit it, implying that I might go on enjoying my own.

It was not that he was doubtful of my brand or had a particular liking for his own, but, as he took care to let me know decidedly, because he was "no grafter."

I would not wish all engineers to be like that.

The implication was that I was trying to buy his favor with a cigar, and it made me feel uncomfortable.

I have a supreme contempt for a grafter, but I should hate to be obliged to guard my honesty by shutting myself out from the common amenities of life.

"Where are you going to draw the line?" asks one of my good friends. "A salesman comes in and offers me a cigar. Ought I to refuse it? You send me a copy of your Indicator book with your compliments inscribed on the flyleaf. Ought I to send it back? One of the companies with which I deal sends me or my wife a Christmas remembrance. I would not have him or you or anybody able to say that I had taken graft from him, but I don't want to be cross-grained. What am I going to do?"

The gage by which I would measure such a transaction is this: Will it stand daylight?

If the boss came along while you were talking with the salesman, would you slip his cigar up your sleeve and try to hide his identity?

If the boss picked up my book, lying upon your desk, and read the inscription on the flyleaf, would you be ashamed of it?

Would you be embarrassed if the boss knew about that Christmas gift?

If your conscience is not entirely clear, if you would have any reluctance to your employer's and the world's knowing all about a thing, it is graft. If it will stand the daylight and does not involve concealment and subterfuge, it is all right.

An engine company installing an engine in a factory presents the engineer who will have charge of it with a pair of indicators. Is that graft? If they gave him the price of a pair of indicators and told him to put it in his pocket and keep quiet about it, that would certainly be graft. If the engineer accepts the indicators under the same conditions and considers them as so much personal portable property to be used and cashed in as he pleases, it is graft just the same.

If the representative of the engine company says to the purchaser, "We want your engineer's good will. He may be interested in keeping our engine up to the mark if he has a pair of indicators, and they will help him to do it. With your approval we are going to present him with a pair," everything is aboveboard and there is nothing compromising to either the engine company or the engineer in the transaction.

If the engineer who has received the indicators makes no secret of it, but shows them to his employer and has it understood that they are not a part of the engine equipment but his personal property, nobody would accuse him of grafting.

Some engineers excuse their acceptance of graft on the ground that everybody does it. It goes with the goods, a sort of a tip or gratuity. If they do not take it, their employer does not get the goods any cheaper and the net result is that they are out something that everybody else is getting and that they might have had.

The engineer will never win for himself a very exalted position so long as he puts himself in the barber and waiter class by accepting tips. If he says that many who do occupy exalted positions and control sales profit by such control, let him apply the daylight rule.

F. R. Low

Driving Power-House Auxiliaries

Types of Auxiliary Drives—Heat-Balance Considerations That Influence Selection of Drives—Alternating-Current Versus Direct-Current Motors — Suitable Voltage for Auxiliary Motors—Selection of Motors for Various Drives

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AUXILIARY machinery in modern steam power-plant practice is driven either by motors or by steam turbines, direct-connected or geared, or by combination of both motor and turbine. The following methods of auxiliary drive may be used:

A. Steam-turbine arrangement to exhaust any surplus steam not required for feed-water heating into the low-pressure stages of the main units.

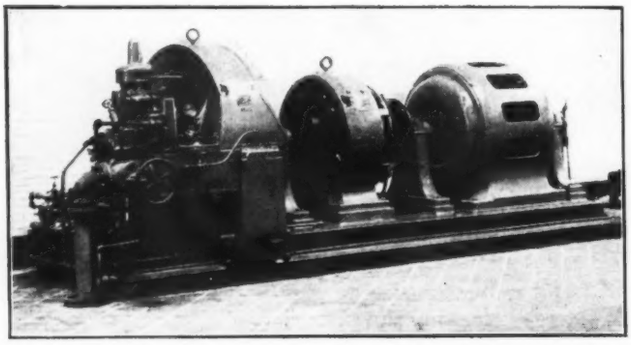


FIG. 1. EXCITER DRIVEN BY MOTOR AND TURBINE

B. Mixed steam and electric, accomplished either by having a portion of the auxiliaries electrically driven and a portion steam-driven, or by some of the auxiliaries having a duplex drive—that is, having both a motor and turbine to drive them, as the exciter unit, Fig. 1.

C. All-electric drive, with arrangement to bleed out steam from the main units for feed-water heating. In some cases economizers are also used.

D. All, or principally all, electric drive, with the bulk of the motors supplied from a separate turbo-generator, called a house turbine. The house turbine generally exhausts into a jet condenser used as a feed-water heater, the condensate of the main units being used as injection water.

E. Scheme (D), combined with the bleeding of steam from the main unit into one or more closed heaters.

In a modern type of steam auxiliary, using 30 lb. of steam per brake-horsepower-hour, the cost per brake-horsepower-hour of auxiliary power will be about 4,500 B.t.u., provided all exhaust steam is absorbed by the heater. Any excess steam that cannot be absorbed will cost eight to ten times this amount. Auxiliary power, when taken from a motor running off the main unit, will cost 19,000 to 25,000 B.t.u. per kilowatt-hour.

In general the smallest thermal cost for auxiliary power is obtained when steam auxiliaries having a minimum consumption per brake-horsepower are used up to the limit of feed-water absorption capacity, and the remainder of auxiliary power required is taken from the main busbars. The installation of economizers will reduce the heat required for feed water, since the water can be supplied to them at a temperature considerably lower than 212 deg. F.

In large plants, house turbines show additional saving over other schemes, due to lower auxiliary water rates and the possibility of operating house turbines under a vacuum at light loads. It is also a material advantage in reliability to have a separate generating unit to supply the more important auxiliaries.

The higher steam pressures and superheats now used in large central stations make the use of a number of small turbines with their attendant steam piping undesirable while, on the other hand, the flexibility and ease of control of motors are important advantages. If a house turbine is used, in order to have a correct heat balance at all loads it is necessary to vary the load on the house turbine, or to change its performance by varying the back pressure for different station loads.

If all auxiliaries are electrically driven, and supplied from a house turbine, in order to obtain a correct heat balance power must be supplied from the main units to the auxiliaries at light station loads, while at heavy station loads the house turbine must generate more power than the auxiliaries require, the surplus being transmitted to the main bus. This requires the house turbine to run in parallel with the main units. The disadvantage of this scheme is that a system disturbance which reduces the voltage and frequency of the main units will affect the house-turbine operation. Even if relays are used to disconnect the house turbine from the main bus under abnormal conditions, they will not

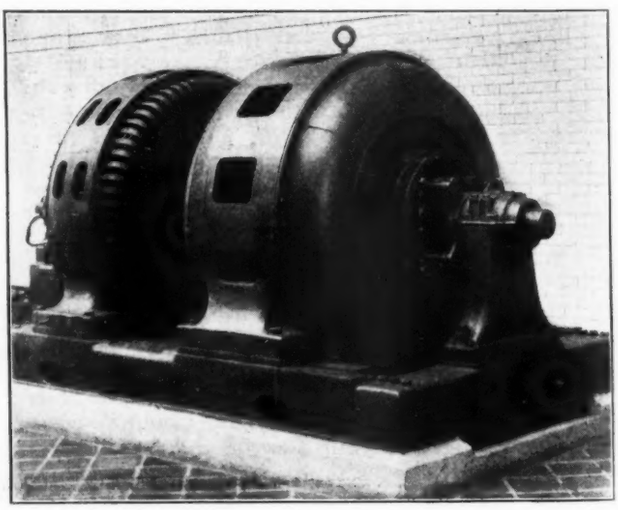


FIG. 2. MOTOR-GENERATOR SET FOR HEAT-BALANCE SYSTEM

operate quickly enough to prevent trouble. To overcome this difficulty, the transfer of power from the main bus to the auxiliary bus can be made through some flexible connection, such as a motor-generator set, Fig. 2, consisting of an induction motor and a synchronous generator. If the motor has 5 per cent slip, in case of system trouble it will require a drop in frequency of 10 per cent of the main bus before full-load is transmitted from the house turbine to the main bus, provided the motor was fully loaded when the trouble began. When a motor-generator set is used, it is generally arranged so that the main units supply all the power for the whole range of station output, the house turbine supplying power to the auxiliaries only. This is done by having part of the auxiliaries electrically driven from the main bus, steam driven, or by bleeding steam from the main unit for feed-water heating.

Another method is to operate the house turbine separately and arrange to switch the auxiliary power feed-

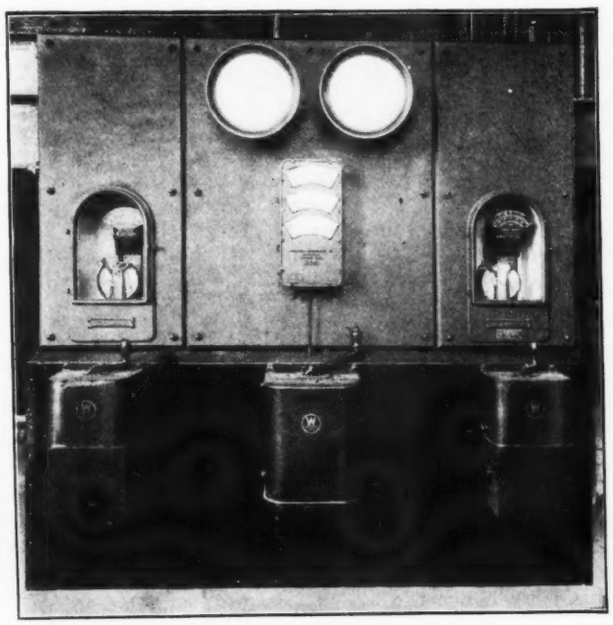


FIG. 3. BOILER-OPERATION CONTROL PANEL

ers either to the house turbine or to the main bus, in order to get correct heat balance.

In connection with the motors and control equipment for auxiliaries the fundamental requirements are strength of equipment and continuity of service. The operation of a unit of 30,000 kw. or higher capacity should not be endangered by an auxiliary motor or control equipment. These large units may operate for two or three months without shutting down, and there is little opportunity of inspecting the equipment while in service. The power requirements for the auxiliaries in a large station are so great that the whole design should be handled from the viewpoint of a large substation located in the power house. The currents that can flow under short-circuit conditions are so large that standard industrial control in most cases is undesirable.

Since all large central stations generate three-phase alternating current, it is more desirable to use alternating-current motors than direct-current. Where methods *"B"* and *"C"* are used, alternating current is generally the only supply available. The advantages of alternating current are: (1) Simple and sturdy motor construction; (2) minimum first cost and maintenance.

Alternating current is not as suitable as direct current, where a considerable speed adjustment is required. The condenser auxiliaries are generally constant speed, but the boiler auxiliaries, forced- and induced-draft fans and stoker motors require adjustable speeds. Where the supply is obtained from the main units, any system trouble causing a drop in voltage and frequency will affect the operation of the auxiliaries.

To obviate this, some companies used a mixed system. For instance, each condenser may have two circulating pumps, one motor-driven and one steam-driven, two condensate pumps, one motor-driven and one steam-driven, and two air pumps, one motor-driven and one turbine-driven. Other companies purchase motors with 50 per cent over-capacity, so that even if the voltage drops to 66 per cent of normal, the motors will not pull out.

Transformers are used to step down from generator voltage to a suitable motor voltage. In some plants one transformer bank is used to supply the auxiliaries of each turbine with a separate bank or banks for other auxiliaries in common to the plant. Other plants use transformer banks that can be paralleled, but under normal conditions supply only a portion of the auxiliaries. When house turbines are used, direct or alternating current can be used for the auxiliaries. The following methods of generating direct current can be used: (1) Direct-current geared turbo-generator; (2) alternating-current turbo-generator, with synchronous converter; (3) alternating-current turbo-generator, with motor-generator set.

Voltage for Auxiliary Motors

Where alternating-current motors are used in large plants, the voltage of the auxiliary motors should be 2,300 for motors of 75 hp. and over, and 440 for smaller motors. The amount of power required is so large that a voltage lower than 2,300 gives a greatly increased first cost, due to the heavy circuit breakers required and the large sizes of busbars and leads.

If direct current is used, 250 volts will probably be adopted, though some plants may use 600 volts. If only a portion of the auxiliaries, such as stoker and clinker-grinder motors, are driven by direct-current motors, 250 volts is more suitable, as it is easier to build adjustable-speed motors for 250 volts than for 600 volts.

In laying out the auxiliary-power equipment, two main schemes can be followed:

1. Feeders installed from the auxiliary power buses to the motors. The control equipment for each motor will be located near the motor and may be hand or electrically operated.

2. The feeder circuit breakers may be combined with the control equipment and all centralized in a switch-room. For example, a common starting bus may be used for all squirrel-cage motors, and a separate feeder with a running and a starting breaker provided for each motor. For wound-rotor motors, a circuit breaker with secondary controllers is provided. The breaker will be electrically operated and controlled by push-button stations at the motor.

Because of the importance of continuity of service, the auxiliary-power supply deserves proper attention in planning both to secure suitable location for the equipment and to have more than one source of power available.

In general, standard motors can be used, excepting

that special attention should be given to all details that tend to increased reliability. Motors having special insulation treatment can be obtained, for either severe moisture conditions or applications where the windings are exposed to coal dust. There is a growing practice in large central stations to bring out all six leads on the stator and apply differential protection so that the motor will be disconnected only in case of internal trouble. In some locations it is desirable to have drip-proof motors. For instance, condensate pumps are generally installed under the condenser and are exposed to drips and leaks. Drip-proof motors should be used in these locations.

Standard auto-starters, as used in industrial practice, are built to rupture only the current of the motor when stalled, and do not have rupturing capacity or mechanical strength for very heavy currents. Their use, therefore, in large power houses should be limited.

Drives for Condenser Auxiliaries

In connection with surface condensers there are condensate pumps, air pumps and circulating pumps, while jet condensers require water-removal pumps and air pumps. Air pumps, when motor-driven, generally run at about 700 r.p.m. and the horsepower varies from 125 downward. They run at constant speed, and squirrel-cage motors are used. Condensate pumps run at about 1,750 r.p.m., and the horsepower varies from 125 downward, squirrel-cage motors being used.

The circulating and water-removal pumps are generally driven by constant-speed motors, though there is a tendency to use a small amount of speed reduction, so as to reduce the amount of circulating water in cold weather. On large circulating pumps it is necessary to use wound-rotor motors to reduce the starting current. In the average installation the circulating pumps start under open discharge conditions. The starting torque generally will not exceed 25 per cent of full-load torque. Direct-current motors will cost considerably more than alternating-current machines and have a greater maintenance cost. As constant-speed motors are largely used for condenser auxiliaries, there is little reason for the use of direct current.

Forced- and Induced-Draft Fan Drives

Forced-draft fans are required for underfeed stokers and for some chain-grate types. In many cases induced-draft fans are necessary where economizers or short stacks are used. There is quite a range in the capacity and speeds of the motors required for this service, and in general, they will range between 100 and 200 horsepower.

The fundamental law of a fan is that for constant discharge the pressure varies as the square of the speed, and the volume varies directly as the speed, therefore the horsepower requirements vary as the cube. In most cases a speed adjustment of 2 to 1 will take care of the range through which modern boilers are worked—generally from 150 to 300 per cent of so-called normal rating. Using alternating current, the following selections are possible: (1) Constant-speed motors, with damper control; (2) varying-speed motors; (3) two-speed motors with damper control; (4) polyphase commutator, alternating-current motors.

Tests made at a large central station indicate that the use of a wound-rotor motor is about 10 per cent more efficient than the use of a constant-speed motor with damper control. The standard equipment used is a wound-rotor motor, and a speed range of 2 to 1 is obtained by inserting resistance in the rotor circuit. At low speeds, however, the efficiency is poor, although the losses are not unduly high on account of the horsepower dropping off as the cube of the speed.

Recently, attention has been given to the use of a polyphase commutator motor, having direct-current series motor characteristics. This motor has good efficiency, but has a high first cost and maintenance charges. It consists of a stator similar to a standard induction motor with a rotor like a standard direct-current armature, but with a much larger commutator. The rotor is connected in series with the stator through a series transformer which generally is arranged to change from three phases to nine or twelve phases. Taps are taken from the series transformer secondary to the commutator. If speed regulation is desired over a large range with low-speed torque at slow speeds, the motor and series transformer are connected in delta for the high speeds and star for the low speeds. Speed variation is obtained by shifting the brushes. Since this motor has the characteristics of a series motor it can run above synchronous speed. At no load, the speed would be dangerously high, therefore an overspeed device is provided.

Motors for Stoker Drives

The power requirements for underfeed stokers is generally assumed as being one horsepower per retort, although this may represent the extreme condition when the stoker is initially installed. Since the stoker consists mainly of rough castings which are not run in the factory, the power requirements are high until the stoker is worn in. This feature should be carefully taken care of if armature control is used, as it will probably mean changing the resistance grids after the stoker is worn in. If antomatic regulation is used, it is very desirable that motors be used in which all the speed variation is obtained by means of shunt-field control.

Motor sizes up to 35 hp. will probably be required with a speed range of 4 to 1. The maximum speed should not exceed 1,200 r.p.m. on account of the chain drive. Probably ten speeds would meet the requirements, although sixteen can generally be given. The service is usually considered as a constant-torque application.

For speed ranges of 4 to 1, the direct-current motor is the ideal one to use. As direct current is not generally available, it is necessary to provide it through the medium of motor-generator sets or synchronous converters. Standard induction motor and synchronous motor-generator sets, or rotary converters of 100, 150, 200 and 300 kw. rating are available. The motor-generator sets for 300 kw. and smaller capacities have a lower first cost than a synchronous converter, but the efficiency is poorer. In most cases motor-generator sets have been installed.

Both 230 and 550 volts are used, but the majority of installations use 230 volts. For 15-hp. sizes and smaller, drip-proof motors (solid covers above the commutator and semi-enclosed below) or totally enclosed motors can be supplied. Above 15 hp. only the drip-proof motors are available. For the control equipment a drum controller, arranged to give two points armature control and sixteen steps by field control, is used. In addition to the foregoing, a protective panel is generally supplied, on which is mounted a two-pole knife switch

for disconnecting the line and a contactor switch for overload and no-voltage protection.

With the requirements of a speed range of 300 to 1,200 r.p.m., the alternating-current motor is severely handicapped. To obtain speed changes the following may be used:

1. A constant-speed motor with a mechanical device to get varying speed. This may be a gear-changing device or a Reeves variable-speed transmission.

2. A wound-rotor motor, obtaining a speed range of 2 to 1, by inserting resistance in the secondary, and using a gear shaft giving 2 to 1 ratio. This gear-shaft device may be embodied in the stoker mechanism.

3. A four-speed squirrel-cage motor, giving speeds corresponding to 6, 8, 12 and 16 poles; that is, approximately 1,200, 900, 600 and 450 r.p.m. on a 60-cycle circuit, with a 2 to 1 ratio gear change, giving in addition 300 and 225 r.p.m. or in all six fixed speeds.

4. A two-speed wound-rotor motor, giving speed range of 1,200 to 600 r.p.m. by inserting resistance in the secondary and then pole changing to get 600 r.p.m. synchronous speed and reinserting resistance again to get from 600 to 300 r.p.m.

5. Commutator-type motor. With the exception of the commutator-type motor, all the foregoing schemes have been used.

It is now usual practice to mount the control equipment for stokers, forced- and induced-draft fans, on a panel together with the necessary instruments for boiler-room operation, Fig. 3, near the boilers.

Clinker grinders are being used on some installations. In general, the characteristics of the motor and control requirements are similar to those for the motor driving the stokers.

Miscellaneous Applications

There are many miscellaneous applications around a power house requiring equipment in line with the usual standard equipment, excepting that attention should be paid to see that starters of sufficient rupturing capacity and rigidity are supplied.

For service pumps, squirrel-cage or wound-rotor motors are used, while for fire-pump applications a squirrel-cage motor generally meets the requirements. On boiler-feed pumps either squirrel-cage motors or wound-rotor motors, the latter capable of giving a speed range from normal to 80 per cent of normal, may be used. On a large dual-drive exciter set the motor may be wound-rotor, in order to reduce the starting current.

Either synchronous or wound-rotor motors are used on air compressors. The usual starting equipment is based on the use of an unloading device to secure easy starting conditions. If a wound-rotor motor is used, no-speed variation is used, the practice being to shut the motor down automatically when the receiver pressure reaches the maximum.

For coal-handling equipment wound-rotor motors are generally used. A usual equipment consists of three motors—one for the crusher, one for the elevator and one for the conveyor. The control equipment is of the contactor type, so interlocked that the motors in each set will automatically start or stop in rotation when the proper button is pushed at any one of several remote push-button stations. A double-throw switch is provided on each board, by means of which the interlocks may be thrown out and the motors adjusted independently.

The Story of Two Staybolts

Characters: Old Staybolt — Much wasted and thinned from age, hard service and bad contact; Newe Staybolt — Full size and almost perfect in shape, but split in two parts lengthwise.
Time: Recently (1921).

Olde Staybolt: Look out, Longfellow, and watch who you are rubbing against!

Newe Staybolt: Beg pardon, sir; I did not mean to rub you so hard; but who are you anyway? You certainly look pretty much used up.

Olde: Oh, I don't know! You look like a split in the Democratic party yourself, but I see that you are but one staybolt when you are pulled together.

Newe: Now don't get rusty. Even if you did nearly lose your head while on the job. Let's be friends, since we have both reached the end of our usefulness in our present state. Let's have your history. How old are you, and where have you put in your time?

Olde: Perhaps my story won't be so interesting when you hear it, because I was on the job when three men were killed, due to a weakness of myself and seven companions.

Newe: You don't mean that, do you? Surely, you were not guilty of killing three men?

Olde: Yes, but I couldn't prevent the loss of the innocent lives. I offered resistance to it to the last ounce of strength in my body, but finally had to give way.

Newe: Well, I'm interested. Tell me the history of your life experience. We both have plenty of time now; we may be here in the scrap pile for several months.

Olde: Well, I was put in a horizontal firebox boiler, commonly called the oil-well type, nearly twenty years ago.

Newe: Pardon me, but what do you mean when you say, oil-well type? Why do you use that term?

Olde: Oil-well, or oil-field, boilers are boilers designed light in weight and cheap in price and usually built without any special supervision. They are made light in weight because they are often taken to hilltops and mountainsides that are sometimes almost inaccessible places. I have also heard old-time oil and gas men say that boilers built of thin plates were quick steamers, especially when made with thin crown sheets. Owing to the difficulties of moving them these boilers are often left standing idle where used, as the cost of taking them to another location would about equal the cost of a new boiler.

Newe: You say that the boiler was built without any special supervision. Do you mean that there was no shop inspector on the job when it was built?

Olde: Inspector! No! not on oil-well boilers. They are built and used without inspection.

Newe: I'm surprised! Who, for the love of Pete, determined the pitch of the staybolts and the joint efficiency, and so on?

Olde: Oh, the boilermaker, or sometimes a shop draftsman did that. In what they miscalled the good old days, the old-time boilermaker was guided by the Government marine rules. Of course these rules are ancient, but you know some folks don't believe in new-fangled rules and button straps for steam boilers. You see, they could make oil-well boilers fast. They punched the rivet and staybolt holes full size or very nearly so, and if the plates at the joints did not fit snugly, a 200-lb boilermaker would put them together by the judicious use of a 16-lb. sledge.

Newe: Gee! But wouldn't the plates be flat along the longitudinal seams?

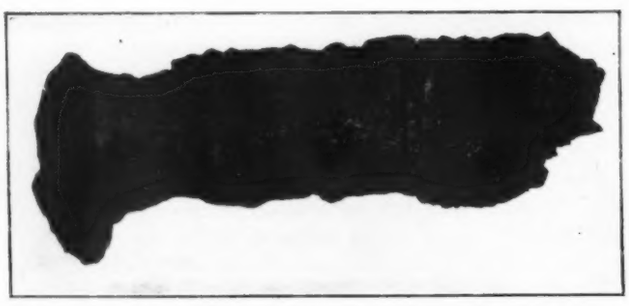
Olde: Sure thing, for a short space, but no one objected. There was no inspector on the job, and the purchaser knew next to nothing about boilers. The rivet holes would be brought in line by the use of a drift pin. Of course the metal was abused and fatigued some, but after the riveting was done, no one could see that.

Newe: Well, go on with your story.

Olde: That is easy enough to tell, but how to get the proper parties to profit by the experience is what bothers me. You see, I was ¾-in. diameter over the threads when put in the side sheet of the boiler nearly twenty years ago. Now a ⅞-in. sheet does not have many threads, but I managed to keep a pretty good hold in the plate all these years. The metal around the hole in the plate, which was abused and tortured when the hole was punched, was eaten away and grooved some by the acids in the feed water. These same acids, of course, attacked the material of my body and a slow but positive action began, not only on my body but on that of nearly all the other staybolts, and we became thinner and thinner at certain points, and I knew it would only be a question of time until some of us would give way. When I started in service, the steam pressure carried on the boiler was 100 lb. per sq.in. and all was lovely then. We bolts were spaced 5 in. by 6 in. or 30 sq.in. to the bolt; that was 3,000 lb. to the sq.in. and we could stand that load without any trouble. But the boiler changed hands several times and some of the fool firemen insisted on overloading the safety valve; that increased our load considerably at times.

Newe: Was the safety valve overloaded when the accident occurred?

Olde: Oh, no! Not a pound. Myself and seven of my nearby companions became reduced in body by corrosion until we were approximately ¼ in. in diameter. And although the boiler was nearly twenty years old, they still carried 100 lb. pressure at times, and the load of 3,000 lb. each was too much for us and when we reached our limit of resistance, we had to let go.

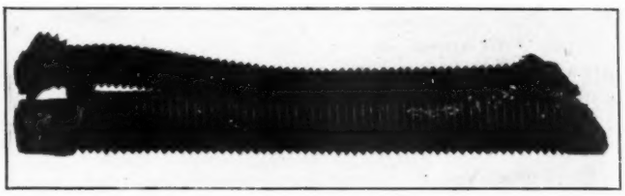


OLDE STAYBOLT. ITS FAILURE KILLED THREE MEN

When eight of us let go at the same time, the side sheet bulged out, pulled over the heads of many of the other bolts, then tore up along the sides and stripped loose from most of the crown bolts and ripped along one side and was blown downward. The escaping steam and hot water scalded three men, causing their death, and the force of the explosion blew the boiler in the air and about fifty yards away.

Newe: That was tough on the men and harder on their families. But I've been turning over a few figures in my mind and I find that if your body was reduced to approximately ¼ in., or a cross-sectional area of 0.49 sq.in., the load on you at 100 lb. steam pressure would equal about 61,224 lb. per sq.in. or what was about the tensile strength limit of the material. No margin, no factor of safety. Surely, failure was inevitable. Such conditions are certainly to be condemned. But tell me, was the boiler never inspected during all the years that your body was wasting by corrosion?

Olde: The only inspections consisted of the "once overs" by country mechanics, who usually looked over



NEWE STAYBOLT. ITS FRACTURE DETECTED BY INSPECTOR'S TEST

the outside and in the furnace door, and several times they were well pleased with the appearance of the boiler because it had a heavy coat of tar paint. Had anyone looked in the handholes with a light placed inside the boiler during the last ten years they could have detected our badly wasted condition, and would probably have prevented the loss of human life.

Newe: Well, my story is shorter than yours. My time of service was mighty short; in fact, I cannot claim to have given any actual service, as I was found defective before the boiler had a fire put in it. The material of which I was made was of good quality, but the heating of it was not just right, and when the round rod was rolled a portion of it was not properly welded, in other words, I was not homogeneous. The imperfection did not show on the surface of the rod, and of course it got by the rolling-mill inspector. The material was compact enough to stand threading and still not show defective. Finally, I was screwed into the side of a large locomotive boiler—one end in the side sheet of the furnace, the other in the wagon top or wrapper sheet. This caused the defect in my body to become more pronounced. When the material at the ends was upset or beaded over, the shocks caused by the blows of the hammer split me practically from end to end. The separation of material was not noticeable at the ends, and while I was seriously split throughout inside the boiler, this could not be seen, and I thought I was booked to give service although defective. I missed my guess, however, as you will see. The boiler was of a standard requiring the ends of the staybolts to be drilled. So there was a ⅝-in. hole drilled in the outer end, extending ½ in. inside the inner surface of the outer plate. The standard specification called for a hydrostatic pressure test of 1½ times the allowable working pressure. When this test was put on the boiler, the inspector was on the job and discovered very slight leakage through the telltale hole. He ordered me taken out, and when removed I was found as you see me, split from end to end, defective, and detected by modern inspection methods. So you can see, Olde Staybolt, there are modern methods of making steam boilers safe.

MORAL: Steam boilers should be designed, constructed and operated under modern safety standards.

Boiler Capacities Obtainable per Cubic Foot of Furnace Volume*

Detailed Test Results on Boilers Operating at as High as 658.9 per Cent Rating—In One Case 2,285 Lb. of Oil Was Burned per Hour per Burner

By T. B. STILLMAN†

IN MODERN stationary-boiler practice larger and larger furnaces have been employed in order to keep pace with the increased capacities at which boilers are operated, and to obtain higher efficiencies through making it possible completely to burn the fuel within the furnace chamber. Large furnaces also reduce tube troubles. With large furnaces more attention must be given to the brickwork construction, and it has been only through patient work in eliminating defects that large furnaces in use today are practicable.

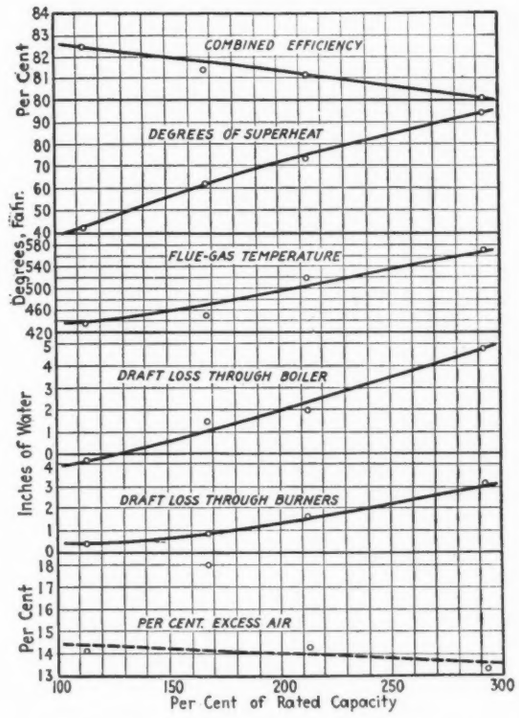


FIG. 1. BOILER-OPERATION CURVES WHEN BURNING OIL

In the case of marine practice boilers and furnaces must be of the minimum size that will give good results, and this leads to the employment of much smaller furnaces than in stationary practice. The use of large furnaces in stationary work is especially noticeable in the case of burning powdered fuel, where from about 1½ to 2 lb. of coal is burned per hour per cubic foot of furnace volume. In some instances relatively large furnaces are provided for burning coal, in stationary stoker practice, where on burning about 2 lb. of coal per cubic foot of furnace volume per hour, the boilers are run at about 200 per cent of rating. In central power-plant practice, where clean feed water is available, the stokers are often arranged so that the boilers can be operated at from 300 to 400 per cent of rating during peak-load intervals, and when this is done, from 4 to 5 lb. of coal may be burned with good efficiency per cubic foot of furnace volume.

As already stated, the necessity for using relatively small furnaces in marine practice leads to considerably higher capacities being obtainable per cubic foot of furnace volume than in stationary practice, and where 4 lb. of coal per hour per cubic foot is ordinarily the limit in stationary coal burning, over 20 lb. may be burned in a marine-boiler furnace. When burning oil in marine-boiler furnaces, as high as 15 lb. may be burned per hour per cubic foot of furnace volume. An attempt should not be made to run at high ratings of the sort without the cleanest of feed water and the highest class of attendance.

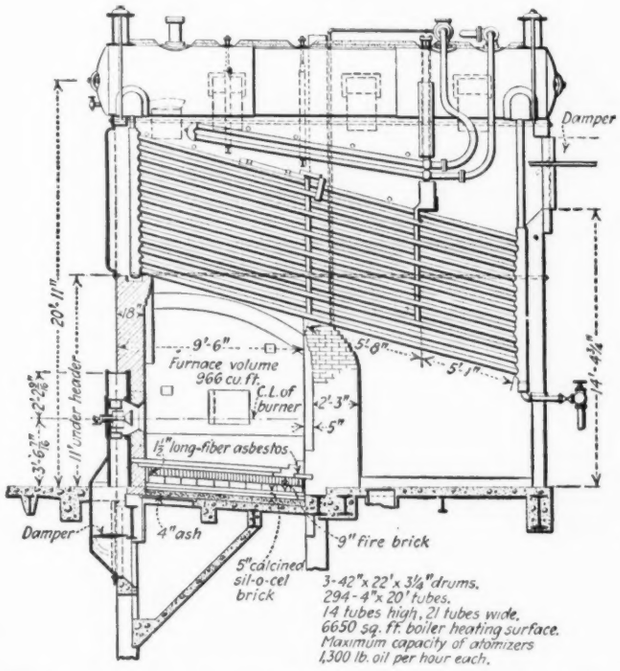


FIG. 2. SECTION THROUGH FURNACE AND BOILER FROM WHICH TEST RESULTS, FIG. 1, WERE OBTAINED

As an indication of what can be done in the way of burning coal per cubic foot of furnace volume, two tests are given in Table I, which were run on a Babcock & Wilcox marine boiler in that company's power plant, Bayonne, N. J. In this case the coal was hand-fired, the forced draft being secured by means of a closed fireroom, under air pressure. The first of these tests was run at what would correspond to 186 per cent rating, the efficiency secured being 73.7 per cent

*Paper presented at the Fortieth Convention of the Association of Edison Illuminating companies, Spring Lake Beach, N. J.

†Babcock & Wilcox Company.

and the coal burned at the rate of 8.55 lb. per cu.ft. of furnace volume. The second test was run at what would correspond to 428 per cent boiler rating, the efficiency being 60 per cent, and the coal burned per cubic foot of furnace volume, 24.2 lb. This last test could hardly be considered seriously from an operating point of view, but is given as an interesting example of what can be done in the way of burning coal per cubic foot of furnace volume when the fuel is fired on a grate.

Turning now to results that can be secured when burning oil, Table II gives some representative examples of what may be expected with this fuel, the first four of these tests being made under stationary conditions and the last three on marine boilers that were in the fuel-oil testing plant at the League Island Navy Yard. The first two tests in Table II are taken from a paper written by Joseph Pope and F. C. Philo, of Stone & Webster; the curves for the complete series of tests that they ran in May, 1920, are shown in Fig. 1. From these curves and test results it will be noted that at 113.7 per cent rating an efficiency of 82.43 per cent was obtained, and oil was burned at the rate of 1.72 lb. per cu.ft. At 293 per cent of rating an efficiency of 80.15 per cent was obtained, the oil being burned at the rate of 4.58 lb. per cu.ft. The furnace in which these results were secured is shown in Fig. 2. The next two tests given in Table II are taken from a series run under stationary conditions on an experimental boiler in the power plant of the B. & W. Co., Bayonne, N. J., the furnace in this case being relatively small, as the boiler was set only a little over 10 ft. high and the furnace only 6 ft. deep from the front wall to the bridge wall. As indicated in the first test of this series, at 116.4 per cent rating an efficiency of 81.8 was secured, the oil being burned at the rate of 2.63 lb. per cu.ft. of furnace volume. In the other test, at 321.7 per cent of rating an efficiency of 75.29 per cent was secured, the oil being burned at the rate of 7.95 lb. per cubic foot.

The fifth test in Table II was run on a B. & W. marine boiler at a rate corresponding to 459 per cent stationary rating. The efficiency secured was 78.64 per cent, and the oil burned at the rate of 9 lb. per cu.ft. of furnace volume. In this test, as with the next two in this table, the necessary air pressure for these high rates of operation was secured by means of a closed fireroom under pressure.

The last two tests in Table II were run on a B. & W. express-type boiler, such as is used in destroyers. The tubes in this boiler are 1 in. in diameter, the boiler being primarily for high-speed work requiring very light weight. Because of the lack of headroom in boats

TABLE I. TEST DATA WHEN BURNING COAL UNDER BOILERS

Date of test	June 14, 1910	June 18, 1910
Duration, hours	24.5	5
Location of boiler	B. & W. Power Plant, Bayonne, N. J.	
Kind of boiler	B. & W.	
Type	Marine	
Heating surface, sq.ft.	2,571	
Furnace volume, cu.ft.	168	
Ratio furnace volume to heating surface	1 to 15.30	
System of fuel burning	Hand-fired	
Kind of fuel	Bituminous	
B.t.u. per pound of fuel (dry)	15,273	15,273
Steam pressure (gage)	201.4	200.4
Feed-water temp., deg. F.	211.4	194.4
Steam quality, per cent	100	99.57
Flue gas temp., deg. F	545	559
Gas analysis, boiler outlet:		
CO_2	13.6	11.6
O_2	4.7	5.07
CO	0.4	1.09
N_2	81.3	82.24
Pounds of water per hour, fed to boiler	15,725	35,501
Factor of evaporation	1.052	1.069
Pounds of water per hour from and at 212 deg. F.	16,543	37.951
Pounds of coal per hour	1,436	4,066
Pounds of coal per hour per cubic foot at furnace volume	8.55	24.2
Water evaporated per pound of coal (actual)	10.95	8.77
Water evaporated per pound of coal from and at 212 deg. F	11.52	9.37
Per cent rating	186.5	428
Per cent combined boiler and furnace efficiency	73.7	60

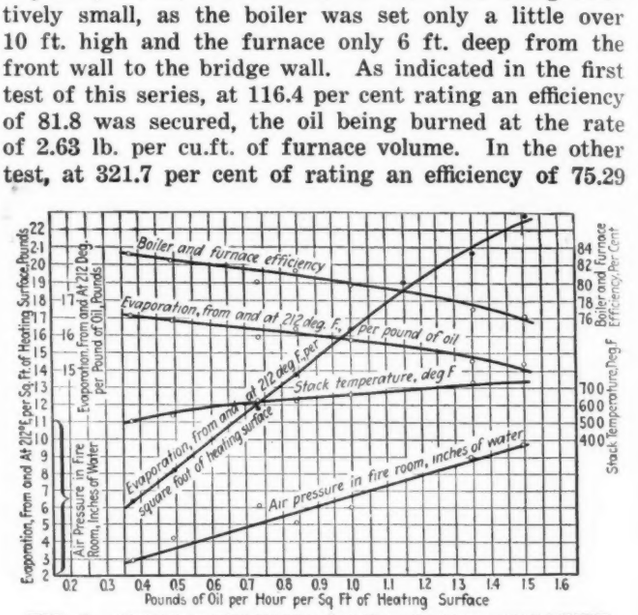

Boiler and furnace efficiency
Evaporation, from and at 212 deg. F. per pound of oil
Stack temperature, deg F
Evaporation, from and at 212 deg F per square foot of heating surface
Air pressure in fire room, inches of water
Evaporation, From and At 212° F. per Sq. Ft. of Heating Surface, Pounds
Evaporation From and At 212 Deg. per Pound of Oil, Pounds
Air Pressure in Fire Room, Inches of Water
Boiler and Furnace Efficiency Per Cent
Stack Temperature, Deg F
Pounds of Oil per Hour per Sq Ft of Heating Surface

FIG. 3. CURVES SHOWING TEST RESULTS OBTAINED FROM EXPRESS-TYPE MARINE BOILER

TABLE II. TEST DATA WHEN BURNING OIL UNDER BOILERS

Date of test	May 18, '20	May 16, '20	Aug. 14, '19	Aug. 21, '19	July 25, '13	June 13, '19	June 10, '19
Duration, hours	4	4	5	3.38	3	3	2
Location of boiler	Savannah Elec. Co., Savannah, Ga.		B. & W. Power Plant, Bayonne, N. J.		U. S. Navy fuel-oil testing plant, League Island		
Kind of boiler	B. & W.		B. & W.		B. & W.	White Forster	
Type	21 tubes wide, 14 tubes high, 11 ft. setting		20 tubes wide, 14 tubes high, 10 ft. 1½ in. setting		Marine	Express	
Heating surface, sq.ft.	6,650		4,500		4,000	7,565	
Furnace volume, cu.ft.	966		445		445	751	
Ratio furnace volume to heating surface	1 to 6.88		1 to 10.11		1 to 8.80	1 to 10.07	
System of fuel burning	B. & W. mechanical oil burners—Lodi design		B. & W. mechanical oil burners—Lodi design		B. & W. burners	B. & W. mechanical oil burners Cuyama design	
Kind of fuel	Mexican fuel oil		Mexican fuel oil		Texas fuel oil	Texas fuel oil	
B.t.u. per pound of fuel as fired	18,471	18,427	18,340	18,200	19,525	19,280	19,300
Steam pressure (gage)	190.0	201.0	178.2	192.1	302	297.1	295.6
Feed-water temperature, deg. F.	213.5	213.0	71.9	71.6	200.6	195.1	198
Quality of steam, per cent	.....	.....	.....	.....	97.89	.....	.....
Degrees of superheat, F.	43.0	94.7	74.7	146.1	.....	39.3	80.8
Flue-gas temp., deg. F.	438	566	413	616	720	490	729
Gas analysis, boiler outlet,							
CO_2	14.3	14.40	13.77	13.70	15.15	12.90	13.03
O_2	1.6	1.43	2.26	2.65	2.73	3.53	3.32
CO	0.0	0.00	0.05	0.05	0.00	0.04	0.09
N_2	84.1	84.17	83.92	83.60	82.12	83.53	83.56
Pounds of water fed to boiler per hour	24,212	60,720	14,586	39,028	60,325	42,523	153,467
Factor of evaporation	1.0766	1.1080	1.2394	1.2798	1.0501	1.1041	1.1206
Pounds of water per hour from and at 212 deg. F.	26,077	67,278	18,078	49,947	63,347	46,950	171,975
Pounds of oil per hour	1,661	4,421	1,169.3	3,537.1	4,005	2,839	11,355
Pounds of oil per hour per burner	415.2	1,105.2	389.8	1,179.0	308	709.8	1,032.3
Pounds of oil per hour per cu.ft. of furnace volume	1.72	4.58	2.63	7.95	9.00	3.78	15.12
Pounds of water evaporated per pound of oil (actual)	14.58	13.74	12.47	11.03	15.062	14.978	13.515
Pounds of water evaporated from and at 212 deg. per pound of oil	15.70	15.22	15.46	14.12	15.82	16.573	15.145
Per cent rating	113.7	293.3	116.4	321.7	459	180.0	658.9
Per cent combined boiler and furnace efficiency	82.43	80.15	81.8	75.29	78.64	83.24	76.15

of the class in which these boilers are used, the furnace volume is kept as small as possible, and accordingly the results secured in such a boiler are of particular interest. Fig. 3 gives in a graphical way the results of a series of tests run on this boiler in June, 1919, the tests at the lowest and highest capacity of the series being given in detail in Table II. In the test that was run at a rating corresponding to 180 per cent stationary rating, an efficiency of 83.24 per cent was secured, and 3.78 lb. of oil burned per cubic foot of furnace volume. The test that gave the highest rating of this series is the last one in Table II, this test being run at a rate corresponding to 658.9 per cent when an efficiency of 76.15 per cent was obtained. The oil burned per cubic foot of furnace volume in this case was 15.12 lb. This test, as in the case of the hand-fired marine boiler, is not interesting so much from an operating point of view as it is for indicating the high ratings that it is possible to secure with oil fuel with relatively high efficiencies, even though the furnace volume allowed for burning the fuel is extremely small. As far as known at the present time, this test represents the highest rate with the highest corresponding efficiency that any boiler has been operated at so far in this country.

During the last year another series of tests have been run on this same boiler with new oil burners of a larger type. During one test oil was burned at the rate of 2,285 lb. per burner per hour, a record in oil consumption per burner per hour which likewise stands at the present time as the highest so far obtained. In other words, this boiler at the present time holds the record for the highest rating ever secured, and the highest boiler efficiency to correspond with that rating, as well as the greatest amount of oil burned per cubic foot of furnace volume and the largest amount of oil per burner per hour.

With these figures before us an interesting point is raised as to how far it is going to pay to go in increasing furnace volumes. Time alone, and many years of hard service with the large furnaces, can give the answer to this, but in the meantime developments along these lines will undoubtedly be watched with interest by the steam-power-plant engineers of the country.

Autogenous Pipe Welding*

By H. B. IGLEHART

IN PIPE welding there are several operations for which there should be specially designed machinery. In acetylene cutting, for example, a machine-operated blowpipe can be used much more economically than the hand-cutting torch, because of its greater speed, both actually and compared to the volume of gases consumed. The machine-operated blowpipe also admits of greater accuracy, thus reducing setting-up operations to a minimum and contributing to faster and better welding.

To make such a weld properly, the ends of the pipe should be chamfered at an angle of 45 deg. and be placed in line, with the tips not less than $\frac{1}{16}$ in. apart, in order that thorough penetration may be had to the inside of the pipe, which must be religiously done in all cases if maximum strength is expected.

The welding rod or wire should be of approximately the same carbon content as the material in the pipe. Much depends on the welder, as no carelessness or guessing must be done in regulating the flame of the torch. The weld should be built up as rapidly as the molten metal can be handled without overlapping, and in a continuous operation all around the pipe.

If the welding flame is moved back over the first part welded for a few inches, the remaining weld is thereafter automatically and homogeneously annealed for all practical purposes.

After completion of a weld a hydrostatic test should be applied to at least double the working pressure to be carried, a vibration test to be added, while the pressure is on, by free use of a medium-weight hammer applied in striking sharp blows around the pipe on each side of, and close to but not on, the weld. This will show up porosity or cold shuts by removing a small particle of oxide, which in many cases temporarily prevents leaks from showing during tests in which vibration is not applied. The reason for not hammering directly on the weld is because in doing so, it sometimes happens that a thin shell is forged over small leaks and later corrodes away, exposing the leak and giving another black mark against welding; it should be charged to the method of testing rather than to the welding.

Regarding the welded neck or branch line, the operation requires a male and female cut, both of which should be machine made. The hole should be cut at a wide angle in order to form a good groove for the weld. The neck or branch must be cut so that it will conform to the inner contour of the main or header. The end of the neck or branch line will not require any bevel or chamfer at its short points, where it penetrates the other pipe. But at its long points, where it merely meets the inner and outer face of the main, it will have to be chamfered fully, the chamfer lessening gradually toward the short points.

This is not necessary in cases where the neck or branch is smaller than the main or header. The smaller the branch compared with the main, the shorter will be the ends on the neck and the less the bevel required at the long point.

The hole must be cut so that, when set up ready to weld, there is the required $\frac{1}{16}$-in. clearance at all points. In welding, it is of course impossible to obtain thorough amalgamation with all the fiber layers or courses of the neck or branch. Extra strength must be added by building up the welds to form a good fillet, say to a radius of about twice the thickness of the pipe.

A neck should never be welded on first and the center cut out afterward, unless it is short and of 14 in. or more diameter, so that the end can be welded over after the cutting has been done, otherwise the weld will be a poor one and have a low efficiency.

Recently, a number of practical demonstrations of welded pipe joints were made under the direction of the writer at the W. K. Mitchell Co. shops. The test pieces were later cut into sections for close examination and are still on exhibition at the Mitchell company's offices.

*From a paper read before the International Acetylene Association, Oct. 4-6, 1921, in New York City.

Photographs were taken at the time. Fig. 1 is a 6-in. pipe about 6 ft. long, with two 4-in. branches welded in; the one marked "old" was a rusty piece; the one marked "new" was free from rust. They were on opposite sides of the 6-in. pipe and about three feet apart. The 6-in. pipe was clamped to a bending table, two eyebolts were attached to the branches, and they were then pulled up by the use of a crane, no filling being in the pipes. The old pipe cracked at an angle of 30 deg.; the new one developed a small crack on the back at an angle of 47 deg., the cracks being about 1½ in. long. The crack on the old pipe went through at one point; the crack on the new one only a third of the way through. The sections of this weld show that it would not have leaked with a water pressure of 500 lb. per sq.in., thus giving indisputable proof of the great strength of acetylene-welded joints. No heat was used when pulling.

The piece marked No. 2 in Fig. 2 is a regular butt weld in 7 ft. of 8-in. full-weight pipe. This pipe was sand-filled and regularly bent hot to a radius of 30 deg., then flanged and tested with 750 lb. hydrostatic pressure. No leaks or any signs of rupture appeared at the weld.

Piece No. 3 of Fig. 3 is made of four pieces of 8-in. full-weight pipe, with a flush butt weld in the center, having a bored-out clipping slipped over it and welded at the ends. To the left is a regular threaded joint with several reinforcing welded tacks. To the right is a regular butt weld. This was sand-filled and regularly bent hot on a 30-in. radius. The two outer welds were cut away and the remainder of the bend flanged and tested to 750 lb. cold-water pressure. No leaks or defects appeared, but even so this form of joint is not generally to be recommended, as it is expensive, being virtually three welds for one. And then there is an element of risk by reason of the unavoidable strain of unequal expansion of the pipe between the two welds and the coupling or sleeve, as the sleeve is of much larger diameter and would have a much lower temperature in any steam line.

Pipe No. 4 of Fig. 4, is 7½ ft. of 8-in. full-weight pipe with a 6-in. neck welded in. This was filled and bent hot on a 30-in. radius, the neck being on the outside of the bend thereby causing a fearful strain on all parts of the welded joint. No rupture occurred, simply a slight elongation of the lower end of the 6-in. neck, due to the natural stretch of the 8-in. pipe.

Pipe No. 5 of Fig. 4 is the same as pipe No. 4 and was treated the same except that, in bending, the neck was kept on the side. Again referring to Fig. 4, pipe No. 6 is made of two pieces of 8-in. pipe welded together at an angle of 30 deg. This was filled with sand and bent back against itself hot. Both parts of the pipe show a decided radius, but the weld is still intact in every way. None of the welds shown by Fig. 4 has any practical value in regular practice, but they forcibly show that good acetylene-welded pipe joints are as strong as the parent material.

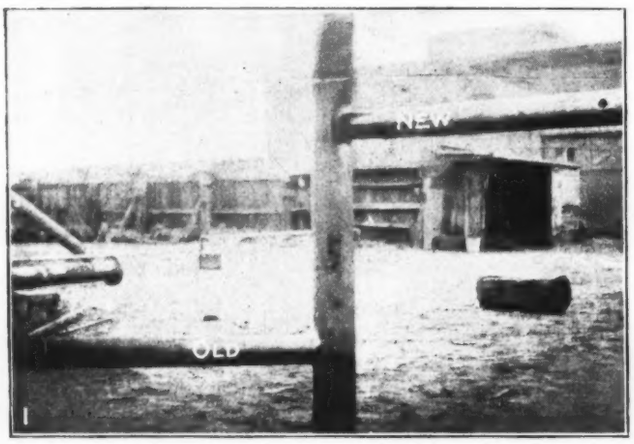


FIG. 1. OLD AND NEW PIPE WELDED TO UPRIGHT

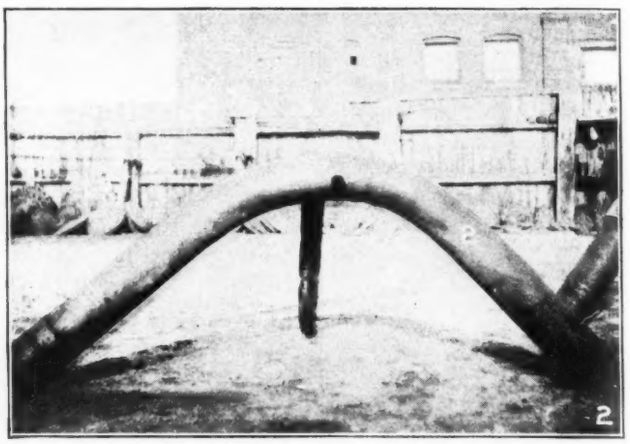


FIG. 2. BENT BUTT-WELD 8-IN. FULL-WEIGHT PIPE

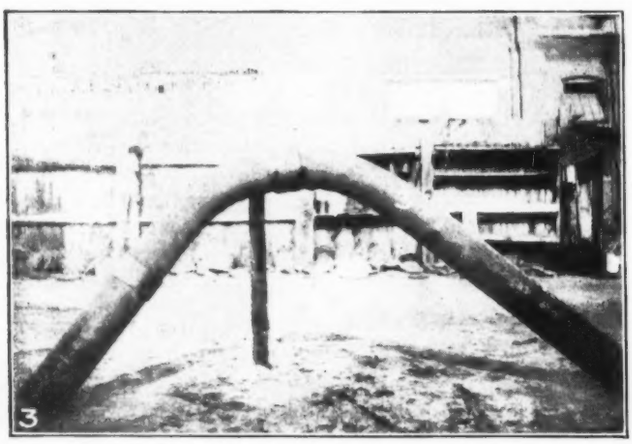


FIG. 3. SHOWING THREE KINDS OF PIPE JOINTS

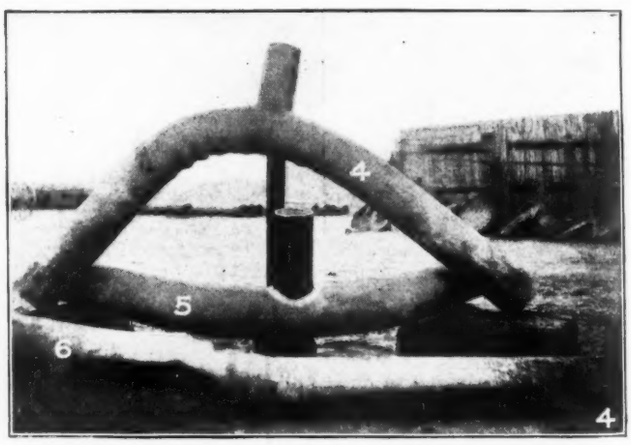


FIG. 4. WELDED NECK PIECES TO 8-IN. PIPE

The Carbonic Refrigerating Cycle

By H. J. MACINTIRE

FOR a long time we have been handicapped by considerable vagueness about the action of carbon dioxide in the refrigerating cycle and also about the physical properties of this substance at various temperatures. This trouble still exists, as compared with our knowledge of steam or even of ammonia, but the latest table on the properties of saturated carbon dioxide, which is reproduced herewith, is a great improvement over previous tables. It is now felt that the latent heat, the heat of the liquid and the specific volume are well enough determined for most engineering purposes.

However, it is next to impossible to understand a cycle of operation without a picture to show it by, and so the diagram Fig. 2 is added for that purpose, and is known as the total heat diagram. It is made up of straight lines showing the effect of condensation or liquefaction of the carbon dioxide, the condition of the substance as to whether it is liquid, part liquid and part vapor, all vapor, or superheated gas, depending on the position on the chart which is taken with reference to the heavy boundary line *XYZ*. For example, the point *X* on the heavy line represents the condition of a liquid at 100 lb. per sq.in., and the straight line *XZ* represents the action of boiling and changing from a liquid to all vapor at *Z*, the intermediate points representing the condition of part liquid and part vapor. Likewise, on the other side of the heavy line *YZ* is the superheated region.

Like the steam or ammonia chart this chart is made out for one pound of the substance and is plotted so that the total heat above 32 deg. F. may be found for any set of conditions. From the diagram the total heat *H* at the point *A* is found to be 101 B.t.u., whereas at the point *B* the total heat is 122 B.t.u. If *A* represents a set of conditions similar to the suction gas entering the compressor—one pound of carbon dioxide being under consideration—then the point *B* will represent the condition of the gas discharged from the compressor into the condenser. This discharge-gas temperature is 145 deg. F., assuming no superheat due to the action of the cylinder walls or otherwise, and the difference of the total heats, 122 — 101 = 21 B.t.u., is the work of compression of one pound of carbon dioxide from 300 to 965 lb.

The superheated gas enters the condenser and gives up its heat to the condensing water—first its superheat and then its latent heat of liquefaction—and finally is represented by the point *C*, still under 965 lb. pressure, as a liquid at the bottom of the condenser at a temperature of 80 deg. F. On passing through the expansion valve, the pressure drops to 300 lb. as represented by the line *CD*. The total heat of both *C* and *D* is 34 B.t.u., and the heat removed by the condensing water is 122 — 34, or 88 B.t.u. per pound. The refrigerating effect is due to the boiling in the cooling coils, here represented by the line *DA* at 300 lb. absolute and a temperature of —0.7 deg. F., this

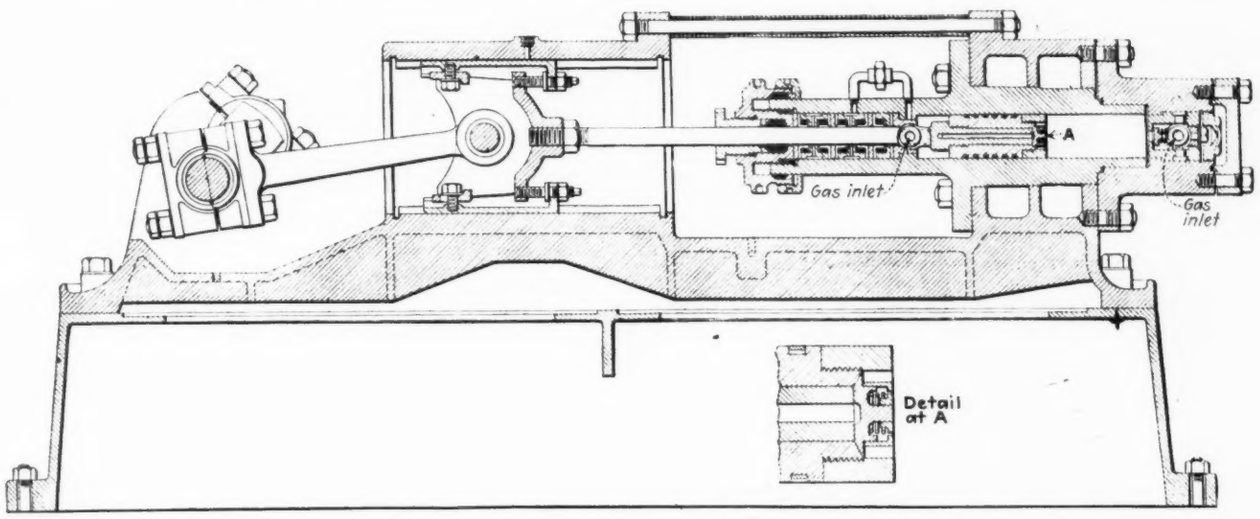


FIG. 1. CARBONIC-DIOXIDE COMPRESSOR

line being controlled by the operator for the condition desired. The difference of the total heats is in this case the refrigeration obtainable, or is 101 — 34 = 67 B.t.u.

The cycle given, *ABCD*, is an example only. If the condensing water was such as to only cool the vapor to 100 deg., the pressure being 1,300 lb. absolute, then the cycle would have been *AEFG*, and 27 B.t.u. of compression work would have been done and 76 B.t.u. would have been removed by the water in the condenser to reduce the temperature of the compressed gas to 100 deg. F., although it could not be liquefied. As a matter of fact, liquefaction cannot occur in the condenser with a temperature in excess of 86.5 deg. F., which is called the critical temperature. However, this fact is of no great moment, as the process *FG* is the action of the expansion valve and the point *G* represents a condition of 58 per cent vapor and 42 per cent liquid. In other words, liquefaction occurs in passing the expansion valve, and the refrigeration effect becomes 101 — 52 = 49 B.t.u. instead of 67 B.t.u. as before.

Again, the gas could enter the compressor in a superheated condition indicated by *H*, and then the compres-

sion line becomes *HJ* with a temperature of discharge from the compressor of 185 deg. F. instead of 145 deg. as before. Superheated gas returning to the compressor, high discharge pressure or low suction pressure means high temperatures of discharge, but incidentally much less than the temperatures to be encountered with

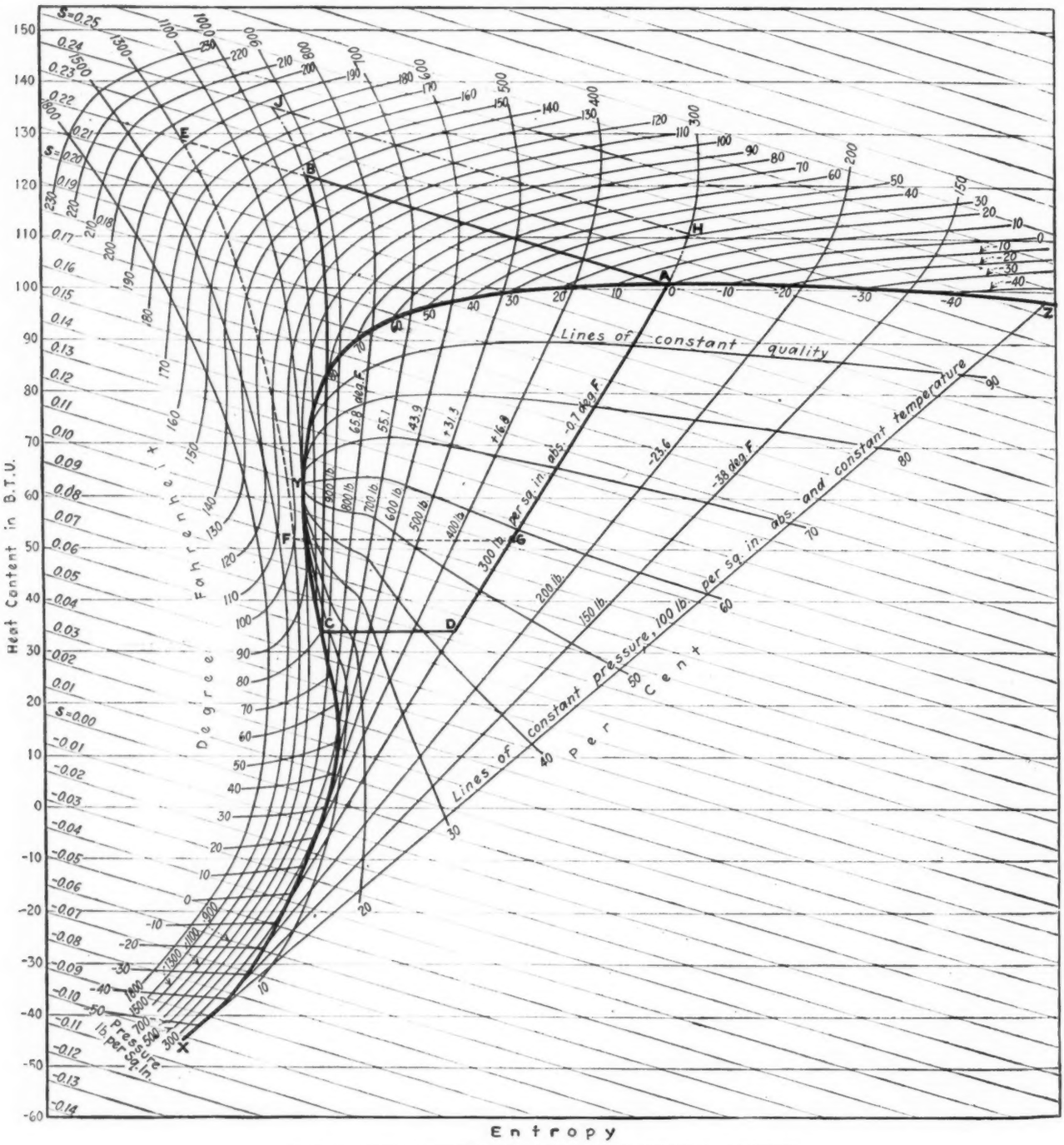


FIG. 2. TOTAL HEAT DIAGRAM FOR CARBONIC DIOXIDE

does not condense in the condenser above 86.5 deg. F. What determines the pressure in the condenser then? Probably this question can be answered easiest by asking what determines the pressure in the aftercooler of the air compressor. The air pressure is regulated by the volume in the aftercooler, the temperature of the gas and the amount of the opening of the valve through which the gas escapes. The same may be said about the carbon-dioxide condenser, which does not condense, but cools the gas to a condition of a dense vapor. The flow through the expansion valve causes liquefaction in accordance with the laws of vapors and is similar (but reverse) to the action of the blowoff cock of

ammonia under corresponding operating conditions. As a rule, therefore, wet compression is not required and, in fact, can be shown to be of a decided disadvantage.

Perhaps the problem hardest to understand is the action of the carbon dioxide above the critical pressure. It has been shown that even at 1,300 lb. the gas

steam boiler which blows out liquid which has all the appearance in the air of steam.

The action of the expansion valve or the pressure-reducing valve is understood to be represented by a condition of constant total heat due to the wiredrawing that takes place. Therefore the total heat of the refrigerant just before and just after the expansion valve is the same, although the pressure is much different. If the refrigerant comes to the valve as all liquid, then (see diagram for the process *cd*) as the pressure drops from 965 lb. to 300 lb., 43 per cent of the liquid evaporates. If the state of the refrigerant is represented by the point *F* (with a pressure of 1,300 lb. and a temperature of 100 deg. F.), then the flow through the expansion valve is indicated as before by a constant total heat line, but this time by the line *FG*, which shows that after entering the expansion coils only 42 per cent (by weight) of the refrigerant is a liquid and is capable of producing useful refrigeration.

Finally, it should be understood that the diagram is constructed for one pound of pure carbon dioxide. The heavy boundary lines *XYZ* are the limiting lines for the saturated condition, whereas to the lower left-hand side is the liquid condition, and the upper part is the superheated condition. The middle of the boundary line *XYZ*, which is called the critical condition, is the limiting condition (both as regards temperature and pressure) where a sharp change from the liquid to the gaseous condition may take place. Directly above the critical point is the state of a dense gas, the unstable state, which has the density of the liquid and behaves like a liquid and yet which does not go through the process of liquefaction as we understood ammonia to do in every practical case, or as carbon dioxide does in the cases where the condensing water is 70 deg. F. or thereabouts, and in suitable quantities. The diagram shows that in every practical case, even with unit pressures of 1,600 lb., some refrigeration is available, but at very much reduced efficiency and capacity at the higher pressures. From the diagram may be obtained, for any particular set of operating conditions, the work done by the compressor, the heat removed from the compressed gas by the condensing or cooling water and the net refrigeration. The total heat diagram is important. If understood, it will solve problems or explain every action of the refrigerant in the cycle of operation. It is worth studying.

PROPERTIES OF SATURATED CARBON DIOXIDE
Jenkin & Pye (MacIntire)

Temp. Deg. F.	Absolute Pressure Atms., Lb. I.	Vol. of Liquid, Cu.Ft. per Lb.	Specific Volume, Cu.Ft.	Heat of Liquid (h)	Latent Heat of Vaporization (l)	Total Heat Above 32° F. (H)
—40	145	0.01438	0.609	—38.7	136.3	97.6
—30	174	0.01464	0.495	—33.5	132.1	98.6
—20	214	0.01496	0.408	—28.3	127.4	99.1
—15	234	0.01514	0.371	—25.7	125.1	99.4
—10	256	0.01532	0.337	—23.0	122.7	99.7
— 5	279	0.01552	0.308	—20.3	120.2	99.9
0	303	0.01570	0.282	—17.7	117.5	99.8
5	329	0.01591	0.257	—14.9	114.8	99.9
10	358	0.01613	0.234	—12.2	112.0	99.8
15	389	0.01637	0.215	— 9.5	109.0	99.5
20	421	0.01663	0.197	— 6.8	105.8	99.0
25	455	0.01689	0.180	— 4.0	102.5	98.5
30	490	0.01718	0.166	— 1.2	98.9	97.7
35	528	0.01748	0.152	1.8	95.1	96.9
40	568	0.01783	0.140	4.7	91.2	95.9
45	610	0.01820	0.128	7.6	87.3	94.9
50	653	0.01863	0.117	10.6	83.1	93.7
55	699	0.01908	0.107	13.7	78.7	92.4
60	747	0.01953	0.097	16.7	74.1	90.8
65	797	0.02000	0.087	19.7	69.0	88.7
70	850	.....	0.078	22.8	63.3	86.1
75	906	.....	0.070	25.9	56.5	82.4
80	965	.....	0.061	28.9	47.1	76.0
85	1,029	.....	0.054	32.0	33.0	65.0
88.4	1,078	.....	0.049	34.0	....	34.0

A Refillable Plug Fuse with a Cartridge-Type Refill

Another type of refillable plug fuse has recently been developed and placed on the market. It is simple and substantial in construction and consists of three parts: A body *B*, Fig. 1, which is made of a heat-resisting molded insulation and contains the bottom contact of the fuse; a cap *C*, made of molded insulation and containing the threaded brass part of the plug; a refillable cartridge *A*, which in reality is a small cartridge fuse. Both ferrules of the refill can be removed to replace the fuse element. When assembling the fuse, the refill *A* is dropped into *B* and the latter screwed into the cap *C*. The size of the refill is stamped on each end and is visible through a hole in the cap.

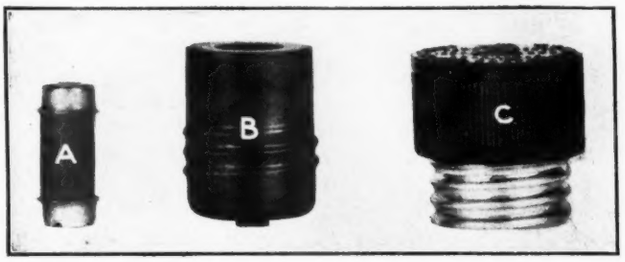


FIG. 1. PARTS OF REFILLABLE PLUG FUSE

A cross-section through the complete fuse is shown in Fig. 2, from which the various parts can be identified and seen in their proper relation in the assembled form. This plug is of the Edison type and renewable for use on circuits of 125 volts with ratings from 3 to 30 amperes, and is manufactured by Cote Bros. Mfg. Corp., Chicago, Ill.

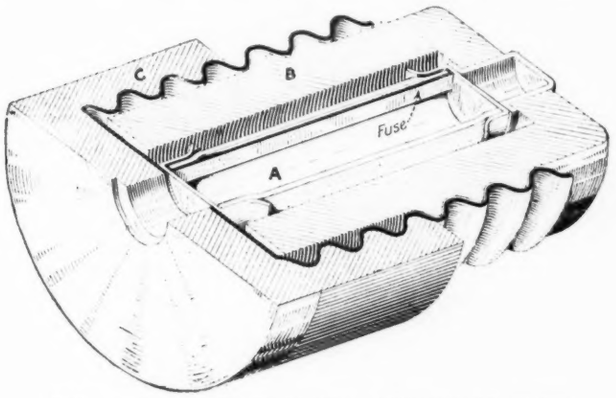


FIG. 2. SECTION THROUGH ASSEMBLED FUSE

For turbo-alternators of 1,000 to 5,000 kva. capacity the required exciter capacity will vary from 0.5 to 0.3 per cent of the alternator's rating, and for machines of 7,500 to 35,000 kva. the required exciter capacity is from 0.4 to 0.3 per cent of the alternator rating, depending upon the type, make of the machine and the service that the alternator is to supply.

The coefficient of friction for well-lubricated surfaces is practically independent of the materials composing the bearings and journals, although dependent upon the nature of the lubricant.

Lubrication—Expansion of Oil With Temperature

By W. F. OSBORNE

WHEN oils are heated they increase in volume, and when they are cooled they contract. If we know the density of an oil at one temperature and its coefficient of expansion, we can calculate its volume at any other temperature.

Oils are bought and sold on the basis of the gallon. But a gallon of oil at one temperature is not a gallon of oil at some other temperature. Consequently, we should always base measurements on the volume at some standard temperature. The temperature accepted throughout the oil industry is 60 deg. F., and all measurements should be corrected to the equivalent gallonage at 60 deg. F.

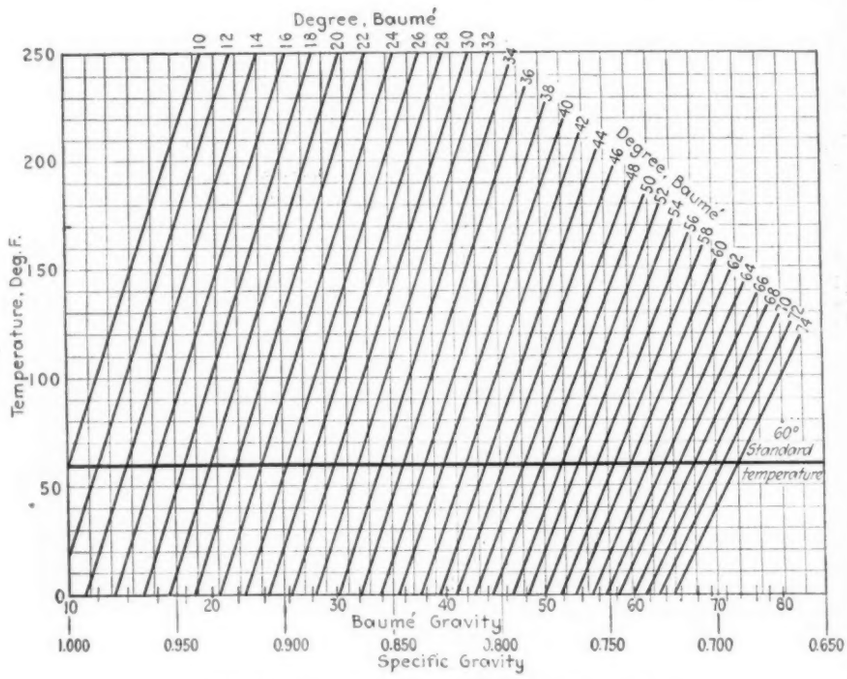
If we know the coefficient of expansion of the oil and the temperature at which its volume is measured, the volume at 60 deg. F. will be equal to the measured volume plus or minus the expansion correction, depending on whether the measured temperature is below or above 60 deg. F. The coefficient of expansion also varies with different oils, being greater for the higher Baumé gravity oils. For practical purposes in power-plant work the following volume corrections are sufficiently accurate: Heavy fuel oils (14-16 Bé.) 1 per cent for each 27 deg. F.; lubricating oils, 1 per cent for each 25 deg. F.; gasoline, 1 per cent for each 15 deg. F.

When more accurate calculations are desired, the chart should be used. Take the vertical line corresponding to the density at the measured temperature and follow it up vertically until it intersects the horizontal temperature line corresponding to the measured temperature. The slanting line which passes through this intersection gives the corresponding density and Baumé gravity at 60 deg. F.

Because of its convenience the hydrometer is almost always used for determining the gravity of an oil. As explained in *Power*, Jan. 24, 1922, the Baumé scale is based on an arbitrary unit and volumes cannot be calculated directly from the hydrometer reading. It is necessary to convert the Baumé reading into the equivalent specific gravity in order to calculate the proper correction to apply.

Take the vertical line on the chart corresponding to the Baumé gravity as read on the hydrometer. Follow it up until it meets the horizontal temperature line corresponding to the observed temperature. Following the slanting line passing through this intersection to the 60 deg. temperature line gives the specific gravity at 60 deg. F. If the specific gravity at any other temperature is desired, follow the slanting line until it crosses the desired temperature line. The vertical line passing through this intersection gives the specific gravity at the desired temperature. For example, 30 deg. Baumé at 100 deg. F. is equivalent to 28 deg. Baumé at 60 deg. F.

The chart can also be used to check the gravities of oils purchased, with respect to standard specifications. Where the chart is not convenient, it is handy to remember that the following relations are approximately correct: Lubricating oils, 1 deg. Bé. for each 20 deg. F.; gasoline and kerosene, 1 deg. Bé. for each 10 deg. F. If the measured temperature is above 60 deg. F. subtract, and if below add, these corrections.



BAUMÉ-TEMPERATURE CORRECTION CHART

Q. In making up the monthly inventories of oils in our storeroom, we find that there is sometimes a considerable shortage or overage, which we are unable to account for unless it is due to the temperature of the oil. How can we correct this?

A. The space occupied by a given weight of any oil varies with the temperature. You should base all gallonage figures on the equivalent gallonage at 60 deg. F. Suppose, for example, that a certain tank measures 1,000 gal. at a temperature of 92 deg. F., and a hydrometer immersed in the oil reads 28 deg. Bé. From the chart you will find that this is equivalent to 26 deg. Bé. at 60 deg. The corrected volume at 60 deg. F. will then be

$$Volume = 1{,}000 \times \frac{Sp.gr.\ at\ 92\ deg.}{Sp.gr.\ at\ 60\ deg.} = 1{,}000 \times \frac{0.887}{0.898} = 987\ gal.$$

For this case the correction amounts to 1.3 per cent.

The Practical Operation of an Underfeed Stoker

OPERATING engineers are always on the lookout for information that will help them to keep up the efficiency of their plants and, what is still more important, to keep current on the line at all times. Useful information is welcome, no matter what its source, but the statements of men who have had the responsibility of running a plant are particularly welcome.

For this reason it is felt that the readers of *Power* will be interested in the following observations of Oscar J. Richmond, chief engineer of the Bridgeport (Conn.) plant of the United Illuminating Co. This information, which was given to a member of the staff of *Power* in a recent interview, does not go into all phases of plant operation, but is confined to practical observations on stoker operation.

The boilerhouse of this plant contains 18 B. & W. boilers, each of which is equipped with a seven-retort, Type AA 4, Taylor stoker having two rams per retort. The following information and instructions are intended to apply only to this particular type and make of stoker.

This article, which is based entirely on actual experience with the Type AA 4 Taylor Stoker, covers the following subjects: Starting up; regulating draft and stoker speed; proper thickness and contour of fire; use and misuse of the long stroke of the lower ram; getting rid of troublesome clinkers; dumping the ash; keeping the lower ram from binding; a kink that insures proper handling of the stoker during standby.

A satisfactory procedure for starting up a cold boiler has been found to be as follows: (1) Fill the hopper with coal; (2) start the stoker and let it run until the front half of the grate is covered to a depth of approximately 8 in. over the tuyeres; (3) stop the stoker and send a man into the furnace with a shovel to scoop out a trough parallel with the front of the boiler along the front edge of the layer of coal (this trough should look about as shown in Fig. 1 and should extend the whole width of the stoker); (4) fill this trough with old oily waste, shavings and wood, and light it or, better yet, fill it with red-hot coke from some boiler that is operating; (5) turn on a very light forced draft, just cracking the butterfly valve in the air duct, and leave this draft on until the green coal is burning about two-thirds way down (this may require about two hours, during which time the stoker is not operated); (6) start the stoker and turn on the forced draft, being careful not to bring up the steam pressure too rapidly (except in emergency about five hours should be allowed).

This type of stoker has two rams for each retort. The stroke of the upper ram is not adjustable. It is therefore evident that the speed of the stoker shaft is determined only by the weight of coal to be burned per hour. This in turn depends on the rating to be carried, the heating value of the coal and the efficiency with which it can be burned. Then, of course, a sufficient volume of air must be supplied to burn the coal at the same rate it is supplied. The draft pressure required to force a given volume of air through the fire varies, being greater for a thicker fire or for a coal that packs more tightly (usually a poorer coal).

From the foregoing it might appear that in adjusting a fire to load changes, the stoker speed would first be adjusted and then the air supply. The actual procedure is just the opposite of this. When the steam pressure starts to fall, owing to an increase in the demand for steam, the air pressure is increased to increase the rate of combustion, and then the stoker speed is adjusted to keep the thickness of the fire constant. The best thickness of the fire does not vary much with the load. For a good coal it will be between 26 in. and 30 in. at the deepest point.

While the stroke of the upper ram is not adjustable, the lower one can be adjusted from a short stroke of about 1 in. to a long stroke of about 6 in. This lower plunger has nothing to do with the rate at which coal is fed to the furnace, but it has a lot to do with the shape of the fire. Except as mentioned later, the lower ram should always be set for the shortest stroke. Then the fire contour will take the proper shape, as indicated in Fig. 2. The continual use of the long stroke on the lower ram will mean bad combustion and the loss of unburned fuel in the ash because it will push the incandescent coal down onto the extension grate before it is properly burned.

There are two times when the long stroke may properly be used. The first is just after dumping the ashes in the manner to be described; the second is when, in case poor coal is being used, a large clinker adheres to the lower part of the tuyeres. At such times the use of the long stroke for a few minutes will ordinarily free the clinker so that it can move on toward the dump plate.

The proper time to dump the ash is when it covers the dump plate to a depth of 12 to 15 in. This may occur at intervals ranging from one-half hour to eight hours, depending on the rate at which the coal is burned and on the percentage of ash. A bad coal will require much more frequent dumping than a good coal, low in ash. The ash should never be allowed to rise to the level of the tuyeres. If this happens, the ram, pushing back against the bridge wall through a solid mass of ash, is likely to shear a pin or even smash the stoker. The procedure in dumping is as follows: (1) Just before dumping, stop the stoker rams and turn on the air that leads to the extension grate, leaving it on until any coke lodging there is consumed; (2) dump the ash; (3) if there are any clinkers too large to drop through, break them with a bar; (4) start the stoker, shut air off the extension grate and put the lower ram on the long stroke and leave it there until coal again covers the extension grate; (5) as soon as the grate is covered, go back to the short stroke and turn on the air supply to the extension grate.

The stoker is designed to give a continual up-and-down motion to the sections of the extension grate. In this plant this motion has been found to be unnecessary and is not used.

With any except very bad coal there is only one thing that is likely to cause trouble, and this can be handled easily if a little care is taken. Reference is here made to the fact that the lower ram, particularly when the coal used is high in sulphur, gradually takes on a coating of hard scale. This in time would take up the clearance and cause the plunger to bind.

This trouble can be obviated by making it a matter of routine to remove the lower ram every six or eight months and chip off the scale with a hammer or cold chisel. The plunger should then be scraped clean. It has been found helpful to finish off by rubbing in some graphite, in the same way that a stove is polished. This is not for lubrication, but to retard the formation of scale. Fig. 3 shows two lower rams. The one on the left has just been removed and has a heavy coating of scale. The other has been properly cleaned and is ready for the graphite coating.

Ordinarily, shearing pins $\frac{1}{8}$ in. in diameter are supplied with the stoker. These have all been collected and thrown away, and replaced by pins about $\frac{1}{10}$ in. (0.098 in., to be exact) in diameter. This was done to insure the stokers being turned over once every two or three hours during stand-by. If the fire should be left for a long period without turning over the stoker it would

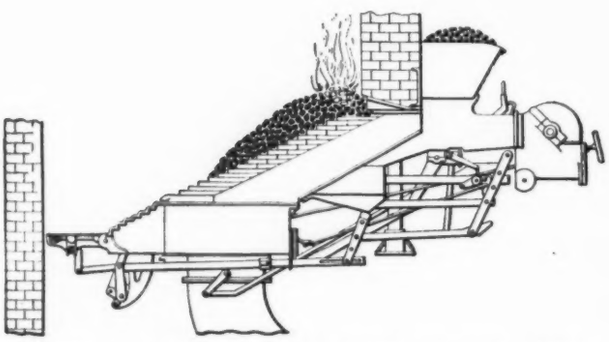


FIG. 1. KINDLING A FIRE WITH RED-HOT COKE

The coke is placed in a trough shoveled out along the top of the green coal parallel with the front of the stoker.

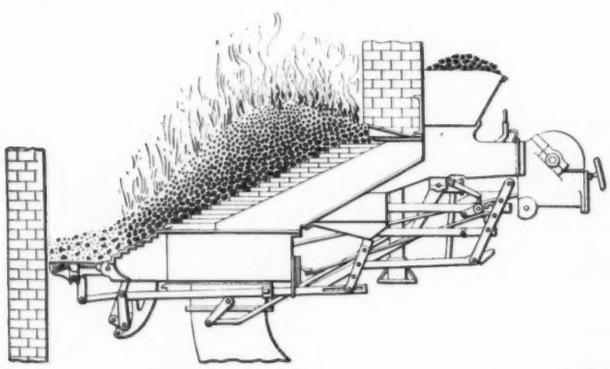


FIG. 2. CONTOUR OF A PROPERLY REGULATED FIRE

coke so hard that it would be difficult for the rams to break through, so that the small pin would shear on starting. When the small pin is used, therefore, the operator is sure to attend to this duty at frequent intervals.

It has been stated that with the precautions mentioned it is a rare thing to have any sort of trouble when good coal is used. Even a high-ash coal causes no particular difficulty if the melting point of the ash is not too low. Such coals form large clinkers, but they are well above the grate and move on to the dump plate without causing any trouble.

During the war it was at times necessary to use very bad coal, high in ash and with an ash of such a low melting point that it ran down through the fuel bed like syrup. This formed a glassy deposit on the tuyeres and

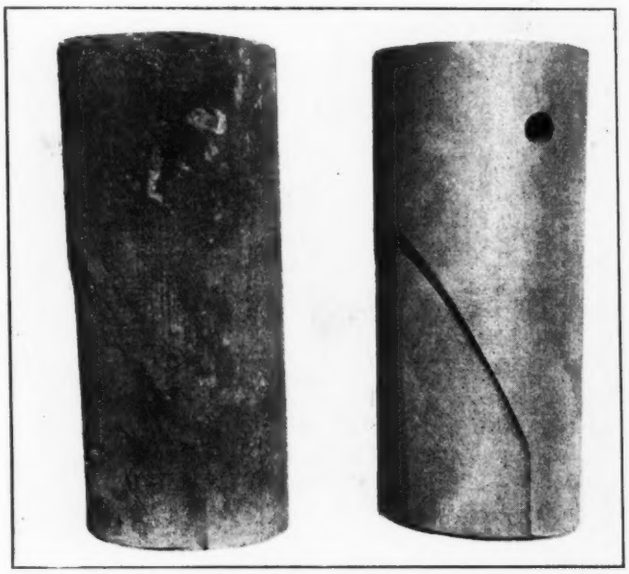


FIG. 3. LOWER RAM BEFORE AND AFTER CLEANING

Left—Ram covered with hard scale after six or eight months' use; right—ram cleaned and ready to be rubbed with graphite.

ultimately necessitated a shutdown to chip it off. Since the war no coals as bad as this have been encountered. In general it seems that the amount of sulphur is the chief element in determining the low melting point of the ash. A coal with more than 1.6 per cent of sulphur should be under suspicion until it is proved that it is all right.

Cinder-Eliminating Induced-Draft Fan

By Gardner C. Derry*

In 1916 an engineer of one of the large power companies in New York City issued specifications calling for an induced-draft fan that would at the same time act as a cinder separator. No quotations were received in answer to this request as there was nothing of the kind on the market. H. F. Hagen, manager of the Research Department of the B. F. Sturtevant Co., became interested in the problem and began to develop something that would serve the purpose. He was experimenting with a paddle-wheel fan, the painted runner of which was not dried. After the fan had been run for about two hours, it was observed that the driving sides of the tees, rivets and the inlet portions of the blades were coated with a fine dust. It occurred to Mr. Hagen that here was an action sufficiently strong to separate cinders from the flue gases. This fan had been run in a research laboratory where the air was not polluted by any manufacturing process and any dust in suspension in the air would be similar to that found in an office room. If a separation of such extremely fine dust was

*Manager Fuel Economizer and Mechanical Draft Department of the B. F. Sturtevant Company.

secured, it seemed that the action would be successful with the much heavier cinders.

The idea was then developed to provide buckets at the inlet edges of the blades of the paddle-wheel fan. There remained only the problem of disposing of the dust caught and separated by the wheel. Therefore inclined

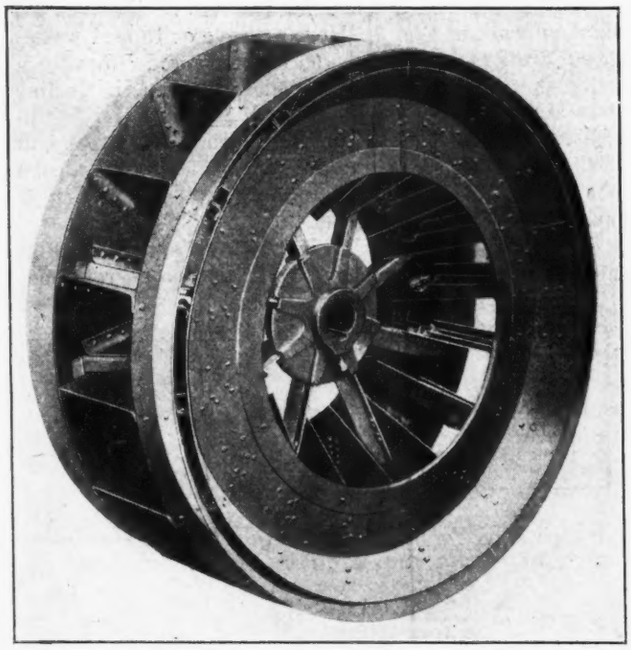


FIG. 1. FAN WITH CINDER-ELIMINATING VANES

channels were provided leading out into the special dust chambers in the fan in which the dust could settle. Since it was impossible to blow the dust with air, as this would involve again a separation problem, it was decided to permit the dust to settle and fall by gravity into these dust chambers, which lead to closed hoppers in which the dust is separated, and from which it can be removed periodically, or continuously by means of screw or other conveyors. From Fig. 1, it is easy to follow the action of the dust in entering the inclined channels and thence to the dust chambers. Several little guiding vanes will be seen which serve to direct the air and cinders in to the inclined channels.

It was found that this cinder-separating fan could be built without taking up any more room and without requiring any more attention than an ordinary induced-draft fan. As a fan it proved more efficient than the average induced-draft fan, and as a separator it was found, on test, to remove 75 per cent of the solid matter in the gases. Naturally, the fan removes a much larger percentage than this of the heavy, coarse materials, but it is this heavy coarse material which drops over the city in the neighborhood of the power plants, causing numerous complaints from the residents located in that section.

Two large fans were installed in a large power plant in New York City and proved to be a success. These fans are installed in connection with six 5,000-sq.ft. boilers, and when these boilers were operating at 200 per cent of rating it was found that each fan was removing 250 lb. of cinders an hour. At higher ratings this would be much greater, and it was estimated that if these fans were placed on all the boilers, they would separate seven tons of cinders an hour. The material separated at this plant resembled a fine coke breeze and showed on analysis some 9,700 B.t.u. per pound.

The maintenance of these fans is practically negligible. The wheel will last as long as the wheel of an ordinary induced-draft fan because the latter is subject to the same abrasive action caused by the cinders against the blades. The housing of the fan will last longer, because some of the cinders never reach the fan housing. The only place where there is any wear is in the cinder chamber of the fan housing. These chambers are provided with easily removable wearing strips of simple forms.

Desirable With Underfeed Stokers

The cinder-eliminating induced-draft fan is particularly desirable for use with underfeed stokers. Underfeed stokers do not cause a serious smoke nuisance, as we usually consider smoke, but when they are operating the boilers at overratings, the necessary high forced-draft pressure blows a lot of the finer portions of the coal over into the stack and these are carried up and discharged over the city. The nuisance thus produced is serious and is getting more so as boilers are being forced to higher and higher ratings. The extremely fine

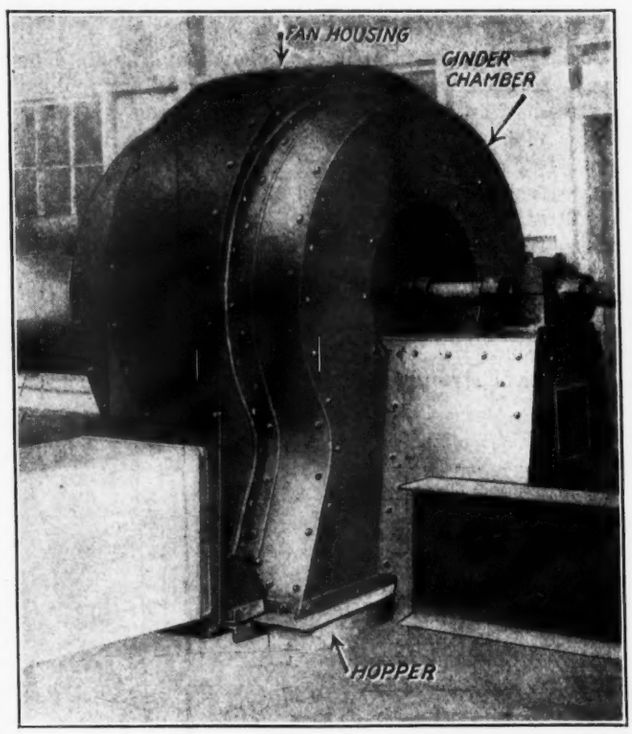


FIG. 2. FAN HOUSING, CINDER CHAMBER AND CINDER HOPPER

particles in the smoke are not particularly objectionable, because they are carried away by the air currents and are not deposited over the surrounding neighborhood, but the dust and cinders in the gases are fairly heavy and fall within a comparatively short distance of the stack.

This design of fan, Fig. 2, has been operating successfully in connection with boilers using pulverized fuel at the British Columbia Sugar Refining Co. at Vancouver, B. C., and many of the smaller fans are used in the various industries for separating dust from fumes in their various processes.

The Steam-Engine Indicator

Reducing Rigs on Modern Engines – Reducing Wheels and Cylinder Connections

WHILE few engines built in the past were provided with a reducing rig by the manufacturer, on practically all modern engines such a rig is incorporated in the design of the engine.

In Fig. 1 is shown the reducing motion supplied by one manufacturer of poppet-valve engines. This is a modification of the swinging pendulum motion familiar to old-time engineers. A stanchion is placed on the engine frame above the guides, being held in a recess by a setscrew. A telescopic lever is swung from this stanchion and is fastened to the engine crosshead by a screw pin *M*. A crosshead *c* is fastened to the lever and reciprocates back and forth in guides as shown. This crosshead carries a hook *a*, while the guide yoke carries a pulley *b*. The indicator cord passes over *b* and is engaged onto the hook. This rig gives a true drum travel, since the ratio of *OC* to *OM* is constant at all points of the piston travel.

High-Speed Reducing Rigs

A very simple motion is that shown in Fig. 2. The crosshead of the engine is fitted with a steel strip which is placed in an inclined position. A Brumbo pulley or sector upon whose grooved surface the indicator cord rests, is fastened to a shaft extending through the engine frame. The inner end of this shaft carries an arm fitted with a round or ball head which engages the under surface of the inclined steel strip. It is apparent that as the crosshead moves back and forth the lever travels up and down through an arc, the angle of which is equal to the angle covered by the movement of the sector. Since the lever end moves on an arc and not on a vertical straight line, the travel of the indicator

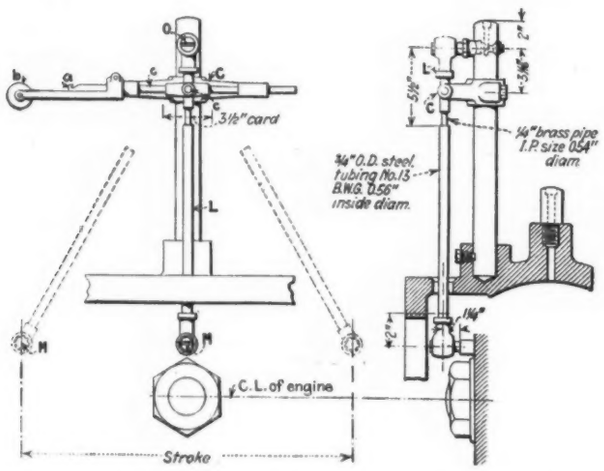


FIG. 1. REDUCING RIG FREE FROM ERROR

cord is not in constant ratio to the crosshead travel. However, the error is negligible if the arc of travel is made small and if the lever is horizontal when the crosshead is at mid-position. The smaller the arc of travel the more accurate this arrangement becomes, and as supplied by the engine builder, the error is well under 0.02 in. in the diagram length.

Another rig which embodies the use of the inclined plane appears in Fig. 3. Here a sleeve or tube *A* passes through the engine frame and carries a rod *B* having a roller at its lower end. The roller rests on the incline steel strip on the crosshead, and as the latter reciprocates, the rod *B* moves up and down. The upper end of the rod carries a horizontal finger *C* to which a cord is attached and, after passing under the roller *D*, is hooked to the indicator drum.

This rig gives an accurate drum travel and is not difficult to attach to any engine. It need not be removed,

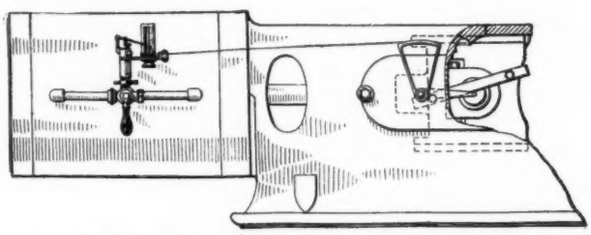


FIG. 2. REDUCING RIG USED ON HIGH-SPEED ENGINE

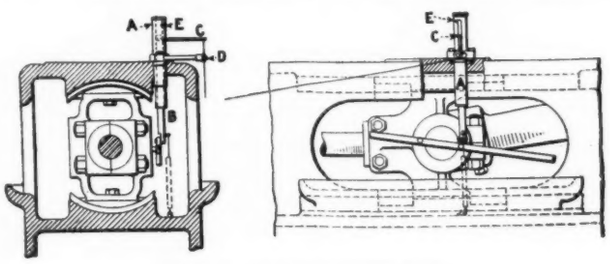


FIG. 3. HIGH-SPEED RIG

since by raising the rod *B* until *C* rests in the slot *E*, the roller is out of contact with the crosshead strip.

Still another rig is shown in Fig. 4. Here a swinging arm *A* is suspended from a bracket on the engine frame and two fingers or guides *B* are attached to the engine crosshead slides in a casting *C* which is pivoted to *A*. The indicator cord is attached to the arm *D*, which is connected to *A* by means of a short shaft passing through the bracket. A number of holes in *D* give a cord travel suitable for all usual diagram lengths. This rig has a small error since the cord travel is not in exact ratio to the crosshead travel, but this error has no perceptible effect on the indicator diagram.

Reducing Wheels

The reader will naturally conclude from an inspection of the several reducing rigs shown that the majority contain entirely too many joints, possess errors, or are entirely too heavy to use on modern high-speed machines. The result has been the designing of reducing wheels whereby the necessity of a rig for reducing the motion of the crosshead to a cord travel consistent with the size of the indicator drum has been eliminated. All such reducing wheels have the general form of Fig. 5. Here a light aluminum groove pulley *B*, which carries the cord connected to the engine crosshead and revolves as the crosshead moves back and forth, is mounted on a

spindle which also carries a smaller pulley *C*. This latter pulley is connected by a cord, as shown, to the pulley *D*, which is mounted on a spindle carrying the wheel *E*. The reducing mechanism is attached to the indicator bracket as shown in Fig. 6, with the indicator drum cord wrapped around the wheel *E*. The several

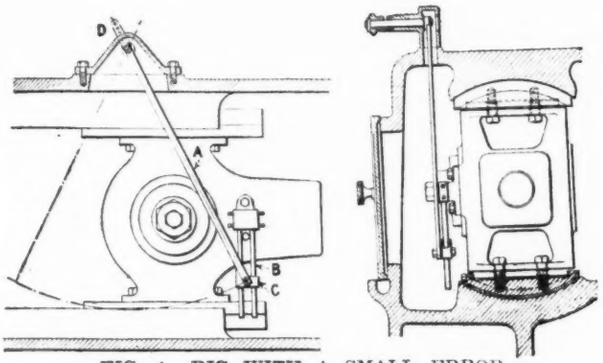


FIG. 4. RIG WITH A SMALL ERROR

pulleys on the reducing wheel are proportioned to reduce the travel of the engine piston to the allowable maximum travel of the indicator cord. This latter travel is limited by the drum circumference to from $3\frac{1}{2}$ to $5\frac{1}{2}$ in. Several of the pulleys *E* are supplied with each instrument to permit it to be used with a wide range of piston travels. Usually, the pulleys give all piston strokes from 10 to 72 inches.

Cylinder Connections

Modern reciprocating steam engines are generally provided with tapped openings at each end of the cylinder barrel. Occasionally, one encounters an old engine with-

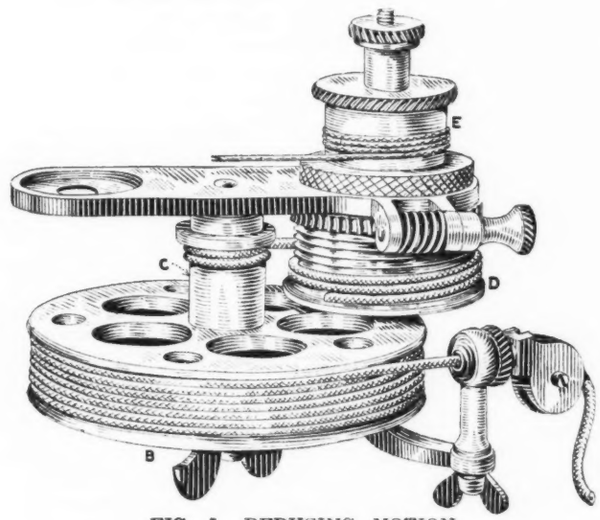


FIG. 5. REDUCING MOTION

out these openings, and it then becomes necessary for the engineer to drill and tap the openings. Frequently, engines have the openings on top of the cylinder barrel in order to have the indicator set vertically. Although this is unobjectionable with small engines, in making connections on the larger units, it is, however, advisable to drill into the cylinder barrel at the side on a horizontal plane passing through the cylinder center-line. This places the indicator, when attached, in a more accessible position than with the connections on top of the cylinder.

When drilling the indicator opening, it is advisable to locate the hole at the extreme end of the cylinder barrel so that the inner end will be in the counterbore, as illustrated in Fig. 7. The piston then never covers the indicator opening, and the counterbore affords access of the cylinder steam to the indicator connections. Many engineers have puzzled over freak indicator diagrams, thinking the engine valves were incorrectly adjusted when the distortions actually resulted from the

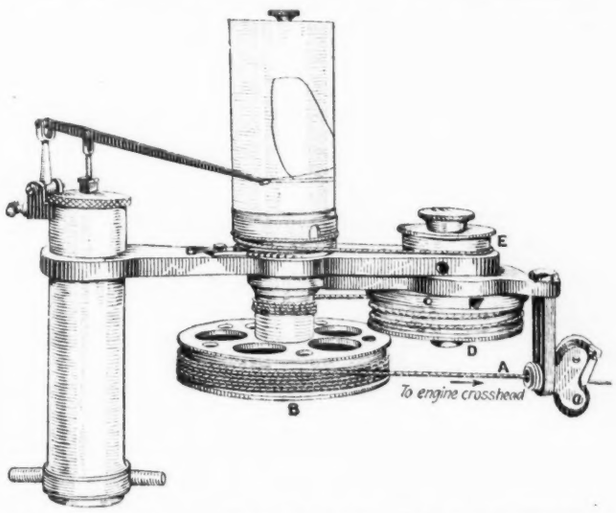


FIG. 6. REDUCING MOTION ATTACHED TO INDICATOR

piston overriding the indicator port. The indicator cock is threaded for a $\frac{1}{2}$-in. connection, consequently the opening into the cylinder should be correspondingly tapped. Precautions should be taken to insure a full passage into the cylinder, and all chips resulting from the drilling should be removed. In the event that the cylinder counterbore is too short to take the full diameter of the

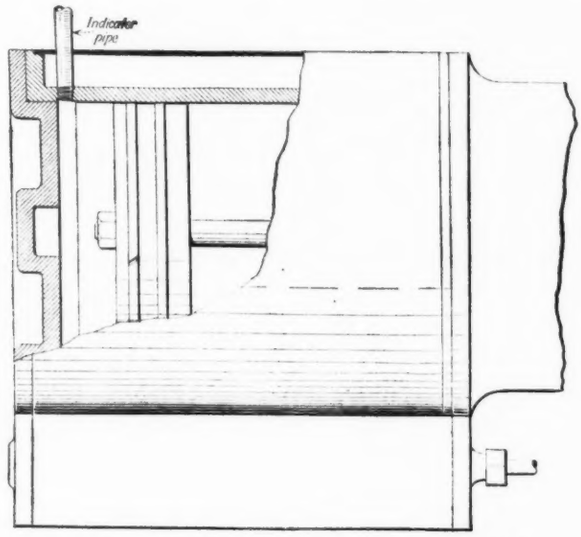


FIG. 7. TAPPING CYLINDER FOR INDICATOR

drilled opening, a groove should be cut along the cylinder wall, forming a small enlargement of the counterbore at the opening.

With openings drilled and tapped, the next step is to attach the indicator to the cylinder. If the connection passes through the jacket lagging, a nipple and coupling will probably be necessary. Some engineers, in order

to place the indicator in a vertical position, use a nipple, elbow and stop cock. This is somewhat objectionable since the distance from the cylinder to the indicator piston is increased. The better way is to screw the indicator cock into the cylinder opening and attach the indicator to the cock. The connection between the indicator and engine cylinder is then more direct.

In order to secure indicator diagrams from both ends of the cylinder without shifting the indicator, in case only one indicator is available, a three-way cock connected as shown in Fig. 8 is used. The disadvantage of

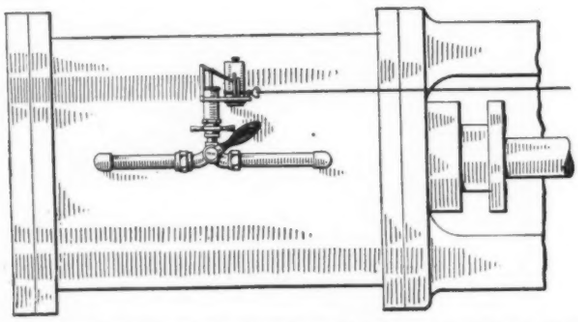


FIG. 8. CONNECTING INDICATOR TO BOTH CYLINDER ENDS

this arrangement lies in the length of pipe from cylinder to indicator. All will recognize the effect such a pipe volume will have on the indicator diagram, especially in case the engine has a very small clearance. The long piping radiates a considerable amount of heat unless covered with lagging such as hair felt, and may cause a pressure drop because of condensation if the cock is not full open or if the pipe is clogged. Whenever possible, two indicators should be used. This, however, does

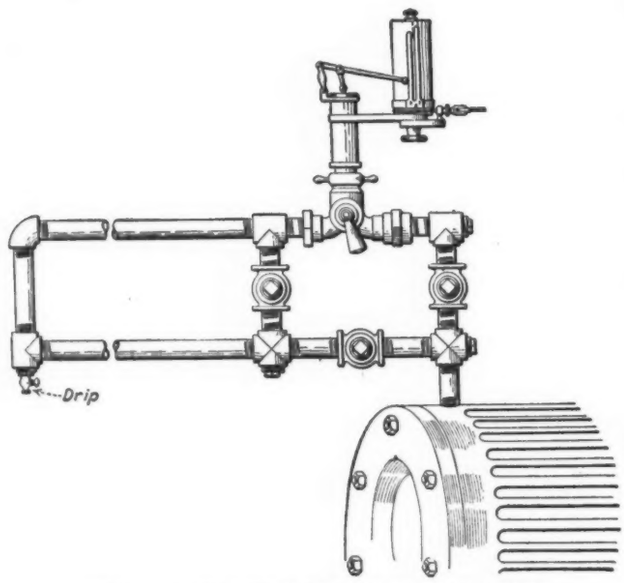


FIG. 9. PIPE CONNECTIONS DURING TESTS

not prevent the double-pipe single-indicator arrangement from being used with success. In any arrangement, the piping should be thoroughly cleaned, all ends reamed or filed to full opening, and on assembling the several parts no white or red lead should be used. It is preferable to avoid all compounds on the threads, but if, due to the condition of the thread, some dope is necessary, litharge and glycerin only should be used.

The effect of long pipe connections was investigated some years ago by A. C. Lippincott and F. R. Low. An engine was fitted with the piping arrangement shown in Fig. 9, in which by manipulating the several cocks steam was admitted directly into the indicator or diverted through several feet of piping before it reached the indicator. In Fig. 10 is shown a full line diagram taken with the indicator connected direct to the cylinder while the dotted diagram shows the result of connecting

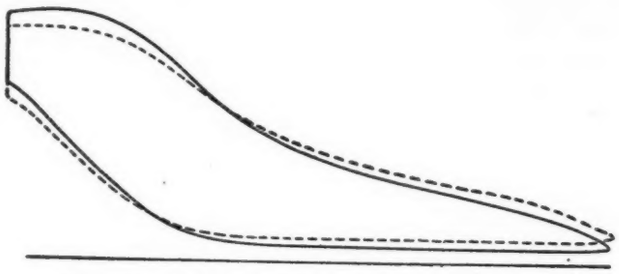


FIG. 10. DIAGRAMS WITH LONG AND SHORT CONNECTIONS

through the long piping. It will be noted that with the latter arrangement the steam pressure is lower, the expansion line rises higher at the lower end, and the compression line is lower. It is apparent that long pipe connections are detrimental.

Thermofeed Differential Feed-Pump Governor

When a pump is used for boiler feeding without a feed-water regulator attachment, the water level in the boiler is controlled by hand by slowing down or increasing the speed of the pump, with the result that it is impossible to keep a constant water level.

What is known as a Thermofeed differential pump governor, when attached to the steam supply of a pump, will not only cause the pump to stop when any predetermined pressure has been attained, but will start the pump again as soon as any predetermined drop in pressure has taken place in the feed pipe.

This Thermofeed mechanism opens or closes a valve of the feed line. The valve disc *M*, Fig. 1, is connected through the spindle *A* with the piston *B*. If steam is admitted to the top of the piston through the pipe *C*, the valve tends to close. On the exhausting of this steam the spiral spring *D* opens the valve.

The steam pipe *C*, Fig. 1, connects as shown at *C*, Fig. 2, with a control valve *E* between which and the pipe connection is a three-way valve *F* by which the mechanism may be cut out of action when desired. The control valve *E* puts the pipe *C* into communication with steam or the atmosphere according to the position of the float *G*. The chamber in which the float *G* is inclosed communicates with the boiler steam space through the opening *H* and with the water space through the opening *J*, consequently the water level in the chamber *I* is the same as that in the boiler.

The control valve *E* is shown in detail in Fig. 3. It consists of a seat and connected cones *K* and *L*. As the water level in the boiler rises, the float *G* in the regulator rises, and by the operation of its toggles pulls the cone *K* to its seat, thus opening a passage between *L* and its seat, which allows steam from the chamber *I* to pass into the pipe *C*, depressing the piston *B* and thus throttling the feed water. When the water level lowers, the

reverse action takes place, the float falls, which raises the cone *L* to its seat, closing the steam passage, and opens *K*, thus putting the pipe *C* into communication with the atmosphere. As the pressure has been removed, the piston *B* is lifted by the spring *D* and the feed-water valve *M* is opened.

When the valve *M* closes, the feed pump must of necessity be controlled to work slower, and this is accomplished by a pump governor which is so designed that an increase of pressure on the discharge side of the pump closes an equilibrium valve on the pump steam pipe, thus cutting off the steam. The action of the governor is shown by Fig. 4. *N* is a pipe containing a water column and is connected at its lower end by a small pipe to the feed-pump discharge, so that the water pressure in this column will be the same as at the valve *M*, Fig. 1.

The top of the column is filled with cylinder oil and communicates through a pipe indicated by the dotted lines with the top of the piston *O* and depresses it against a coil spring should the pressure be high enough. The nut on the end of the piston rod may be so adjusted that at any desired pressure in the feed pipe the piston *O* descends far enough to push down the spindle *Q*, at the lower end of which is a control valve *R* similar to the valve *E*, Figs. 2 and 3. When the spindle *Q* is pushed down, the movement of the control valve admits steam to the top of the piston *S* through the ports shown, thus closing the valve *T*, which slows down the pump.

When the pressure in the feed lines decreases, the piston *O* rises and a spring *U* and its lever lifts the control valve *R*, which places the top of the piston *S* into communication with the atmosphere, thus enabling springs to open the equilibrium valve *T* and admit more steam to the pump.

These devices are manufactured by the White Fuel Oil Engineering Corporation, 742 West 12th St., New York City, a subsidiary of the Todd Shipyards Corporation, New York City. They are also made by the Ronald Trist & Co., Ltd., Dinneford House, 12 Clipstone St., London, W. I.

Heat may be carried from one point to another in three ways—by conduction, by convection and by radiation. Conduction means that the heat first raises the temperature of the material at the point of generation. This heats up the next layer of material, which heats the next and so on. Convection means that there is an actual movement of heated matter from a point of higher temperature to one of lower temperature. Therefore convection can occur only in a gas or a liquid. Radiation has the same nature as light and travels at the same speed, about 180,000 miles per second. Unlike either conduction or convection radiation can take place through a perfect vacuum. In that way the sun's rays pass to the earth in about eight minutes. The amount of radiation is small at low temperature, but increases very rapidly as the temperature goes up. This accounts for the large amount of heat absorbed by the first row of tubes in water-tube boilers especially when being forced with high furnace temperatures.

Belts cut from along the spine of the animal generally run straightest because of more equal lateral stretching qualities. They are to be recommended for high speeds.

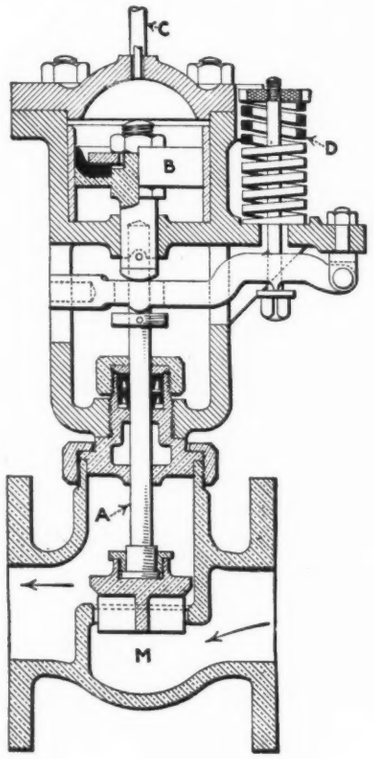


FIG. 1. FEED-WATER REGULATING VALVE

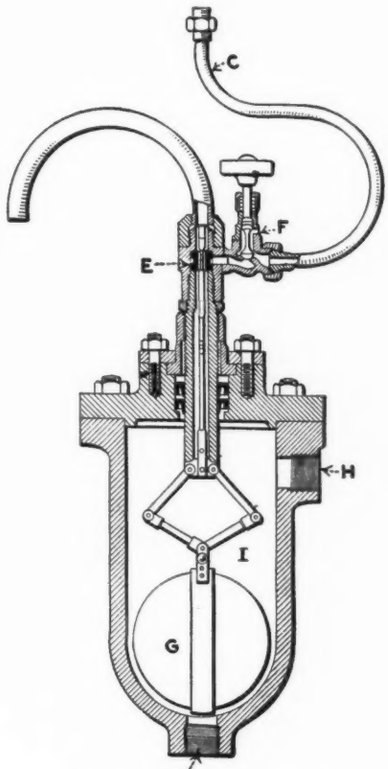


FIG. 2. CONTROL-VALVE CHAMBER

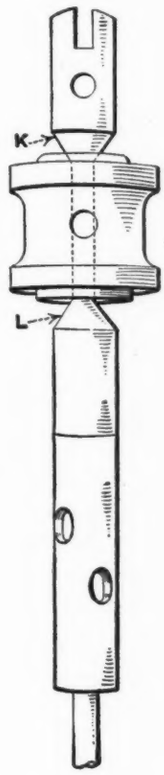


FIG. 3. CONTROL VALVE

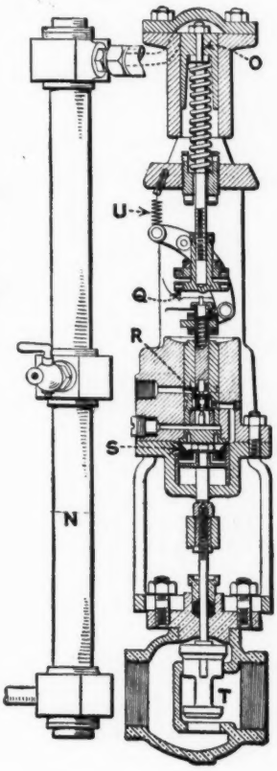


FIG. 4. THE PUMP GOVERNOR

Preventing Troubles in Commutators

By Charles A. Armstrong

When cutting mica for commutator insulation, it is quite general practice to clamp a number of the strips in a vise between two commutator bars as a guide and then, with a hacksaw, cut the micas to the shape of the bars. This is a quick job, but it is difficult to make the insulating segments all the same size as the bars. Even

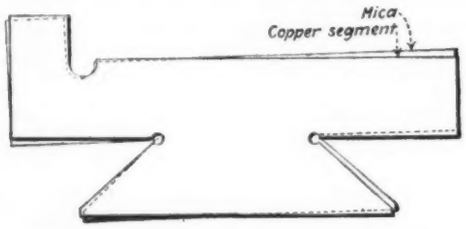


FIG. 1. SHOWS HOW MICA MAY SHIFT WHEN THE COMMUTATOR IS ASSEMBLED

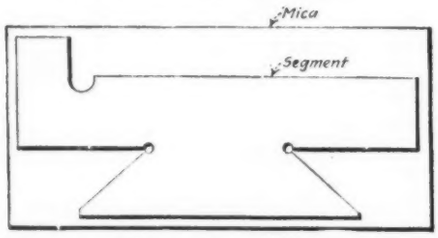


FIG. 2. HOW MICA IS SHELLACKED TO THE BAR BEFORE CUTTING

when each insulating segment is marked off individually and cut, the segments are not all the same size as the bars. It has been found in practice that some of the insulating segments, instead of remaining in line with the bars, tend to shift as shown somewhat exaggerated in Fig. 1. Especially is this true if the insulation happens to be smaller than the bars. In assembling the commutator this makes it difficult to get a good, solid fit, with no small spaces where copper and carbon dust can lodge and cause short-circuits. If the insulation happens to be a little too long, then when the commutator is assembled, the excess length is forced back between the bars, which prevents them from making a good, tight fit with the insulation for their entire length.

All these difficulties can be easily overcome by shellacking each bar to a mica strip and then cutting the mica to the exact size of the bar. The shellac is applied to the mica strip and the bar heated to a temperature where it will not be too hot to handle with the naked hand and placed on the mica as in Fig. 2. Heating the bars helps to dry the shellac quickly. After the bars have been stuck to the mica, it is an easy job to cut the insulation the exact size with a sharp knife. Now, when the commutator is assembled the mica must stay in its place and a good, solid fit is obtained. In one case in mind, where the commutators were assembled with loose mica insulation, a great deal of trouble was experienced with defects developing in the commutator after the machine had been in service for various periods. However, since the practice of shellacking the mica to the bars was adopted, this trouble has practically disappeared. It takes a little longer to do the job, and consequently costs more to insulate a commutator in this way, but the additional cost is saved many times in reduced maintenance charges.

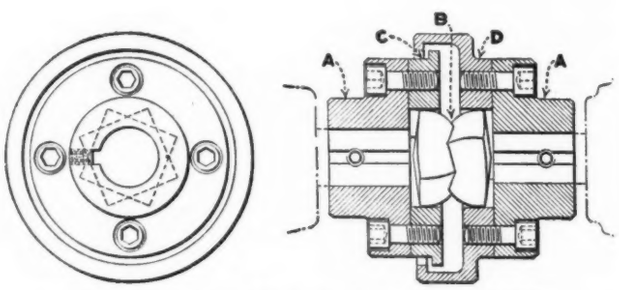
Shellacking the other side of the mica when the commutator is being assembled has been tried, but this did not work out satisfactorily. When the commutator was heated during the tightening process, the shellac would stick the segment to the insulation and prevent the commutator from being drawn up tight. With the insulation shellacked to one segment only, the other surface is free to move on the surface of the adjacent bar, so that a good, tight fit is obtained. Care must be taken to get all the old insulation off the bars. If this is not done, the commutator will not make up good and tight, and defects are sure to develop in service.

Whitney Free-Floating Coupling

With the general design of flexible couplings it is necessary, in the instance of motor- or turbine-driven pumps or generators, practically to disassemble both units in order to remove one or the other from its casing. This is not necessary with the Whitney free-floating coupling, as because of its design the coupling element can be removed from the coupling without disturbing either the driving or the driven unit.

This coupling, which is made by the Kay Manufacturing Co., Norwalk, Conn., consists of two hubs *A*, a link *B*, an inner ring *C* and an outer ring *D*. Both the inner and outer rings are secured to the two hubs by capscrews, the heads of which are in countersunk holes in the hubs. Clearance between the inner and outer rings permits the coupling to adjust itself to any misalignment of the shafts.

After the capscrews have been removed the rings *C* and *D*, together with the link *B*, can be taken out without disturbing the hubs *A* and *B*, after which either the driving or driven element can be removed from its casing, or the unit as a whole can be taken from its base without disturbing the other unit.



END AND SECTIONAL VIEW OF COUPLING

The hydraulic efficiency of a centrifugal pump is the theoretical head against which the pump would deliver if there were no losses, minus the hydraulic losses, divided by this theoretical head. The losses consist largely of those in the suction pipe due to friction, impeller losses, those in the discharge vane, casing loss due to shocks and eddies and a discharge velocity head necessary to carry the liquid away from the pump, but which is unutilized.

The term "miner's inch" was formerly much used and in some of the Western States it is still sometimes employed locally as a unit to measure water sold for mining and irrigation purposes. It is the quantity of water that will flow through a one square inch opening in a plank under a head of six inches.

EDITORIALS

St. Lawrence Power

UTILIZATION of St. Lawrence power has been placed a step nearer realization by the report of the International Joint Commission, which is now in the hands of Congress.

Obviously, the question of power is contingent upon the waterways project. Therefore, for the present, at least, its fate depends upon whether the agricultural and other interests of the West and Northwest will be able to overcome the opposition of New York State and the Eastern railroads.

Estimates of the power available vary from nearly a million and a half to over five million horsepower, depending upon the extent to which it might be found commercially desirable to construct the necessary dams. The lower figure is that contained in the Wooton-Bowden plan for harnessing the Long Sault Rapids, which is indorsed by the International Joint Commission.

Inasmuch as it would require some years to complete the project, the question of markets need give little concern, for if the estimates of the Superpower Survey are to be accepted, the growth of industrial power demands within transmission distance of the St. Lawrence will by 1930 exceed that which may be rendered available from this source and still leave plenty of load for the larger steam plants.

Moreover, any loss that New York State might suffer through diversion of shipping would probably be offset by increased manufacturing activity.

To what extent the tail can wag the dog will, in this instance, depend upon the pressure that can be brought to bear on Congress by all who appreciate what adequate power means to every industrial community.

Motors for Driving Power-Plant Auxiliaries

DRIVING all auxiliary equipment in the power plant with electric motors and bleeding the main turbines for feed-water heating is generally accepted as the most efficient as concerns the plant as a whole. With this scheme the auxiliary power is supplied from the main generator. With regard to reliability such an arrangement is at a disadvantage in that any disturbance on the system is likely to shut down the motors driving the auxiliaries, which would probably result in considerable delay in getting the station back into service. For this and other reasons all-motor drive has not been considered practicable except in special cases, where the plant is tied into a system with a number of other plants. Effort to approach this most economical method of all electrical drive for auxiliaries, without jeopardizing the reliability of the plant, has led to the development of a number of different schemes combining steam and electric drive for the auxiliary equipment. These are outlined and discussed in "Driving Power-Plant Auxiliaries," the leading article in this issue.

In the application of motors to auxiliary drives no special problems arise that are not found in ordinary standard applications. The auxiliary drives may be generally grouped as pumps, fans, generators and conveyors. The stokers may be classed as conveyors, requiring adjustable-speed drive. Motors that are used on the stoker and coal conveyors are subjected to coal dust, and those around the condenser are exposed to drips and leaks. These conditions, combined with the necessity of high reliability in the motor, make a special insulation treatment desirable in the machine.

Special consideration should be given to the controller for the motor. The motor and controllers, being located near the main busbars, will be subjected to more severe conditions than those located out in an industrial plant with long transmission and distribution lines and two or three banks of transformers in the circuit. In case of a short-circuit all these tend to limit the current that may flow, and relieve the control equipment of the strain. In industrial applications the contactors of controllers are in general frequently opened and closed, as there are few applications where the motors are in continuous operation for long periods. Opening and closing of the contactors, although it may cause wear of the parts, keeps the current-carrying surfaces of the contactors clean and prevents heating. On power-plant auxiliaries contactor switches on control equipment may be closed continuously for weeks and even months. This gives the contact surfaces a chance to become oxidized, and if they are not liberally designed, or watched closely while in operation, serious heating may be the result.

As compared with the units they serve, the cost of auxiliary drives is comparatively small, therefore everything should be done to make them as reliable as possible. The cost of having a thirty-thousand-kilowatt or larger unit shut down soon runs up into figures that would pay for the auxiliary equipment. Therefore it is false economy to try to save in the first cost of auxiliary drives at the expense of reliability.

For Power or For Fertilizers?

DEPENDING upon the interest of the individual in question, the further development of the Muscle Shoals power and nitrate plants takes on a different aspect. Power-plant operators and large users of power look upon these undertakings, which are now so much in the public eye, as power projects. But the agricultural interest of the country, the chemical industries and the politicians who are seeking to support these developments seem all to emphasize the projects as ones for the production of fertilizer. As a matter of fact, both factors enter and both must be considered. But behind all this is the primary purpose of the plant—the adequate production in this country of nitrates for the manufacture of explosives in the time of war.

Rowland Thomas, in a spirited attack upon the Ford offer in the New York World, makes an extended argu-

ment upon the assumption that this plant cannot make good as a fertilizer property as it now stands. This is literally true, but the impression which the argument conveys is far from the facts.

With relatively little expenditure, nothing at all comparable with the larger outlay that must be made for dam and power house, the nitrogen fixation plant at Muscle Shoals can be made a fully effective commercial unit. It will be entirely possible, as has been amply demonstrated by commercial experience there and elsewhere, to produce in this plant large amounts of the fixed nitrogen for fertilizer use in the form of ammonium sulphate, ammonium nitrate or cyanamide. All three of these compounds are satisfactory fertilizer constituents if not used in excess. The first two are, in fact, of the highest possible fertilizing value per unit of nitrogen contained. Ammonium sulphate is used extensively already in mixed fertilizers and, so used, is an entire success. It contains, in fact, one-third more nitrogen per pound than does Chilean nitrate, the other principal nitrogen-bearing fertilizer material. The ammonium nitrate, though not widely used because of its high cost and certain mechanical troubles in handling, is a demonstrated success as a fertilizer material and is even more valuable per pound because of the higher nitrogen content.

The opponents of Mr. Ford's offer are misusing the facts when they say that further development of that plant cannot supply fertilizer materials. As it stands today even without the development of the Wilson Dam or the construction of Dam No. 3, both of which will be made operable under any such plan as Mr. Ford proposes, the plant at Muscle Shoals can make, in fact has made, fertilizer materials successfully.

The Carbonic-Dioxide Refrigerating System

OWING to certain disadvantages more fancied than real, the carbonic-dioxide refrigerating system has not had the vogue in America that it has experienced in Europe. However, of late several firms have taken up the manufacture and its advantages are being given more attention.

The chief objection raised is the high pressure under which the compressor must operate. Modern design employing all-steel cylinder construction has overcome the disadvantage, while the elimination of direct expansion coils has removed the likelihood of leaks. The gas has the distinct advantage of not being dangerous, making the system especially suitable for small installations in congested districts.

The heat diagram chart and table of properties of carbon dioxide appearing in this issue have not been published heretofore in America and are of extreme importance to refrigerating engineers. A study of the chart shows that, theoretically, carbon dioxide requires but little more power per ton of refrigeration than does ammonia. Practically, there is an increase in the horsepower requirements, but not sufficient to affect seriously the relative economies.

As pointed out by Professor Macintire in the article under discussion, many engineers hold the mistaken notion that with high cooling-water temperatures the system fails to secure any refrigeration. The author points out that even though nothing but gas above the critical condition passes through the expansion valve, refrigeration is secured, but at a reduced rate. The relative results secured with the cooling water under several temperature conditions are shown in one of the charts. Even with very high temperatures some refrigeration is secured. Consequently, the carbon dioxide may be safely installed in any part of the country, even if the water temperatures are high during the summer months.

Use the Index

FEW engineers are walking encyclopedias, but one of the essentials of their training is ability to know where to find and then apply engineering information. The source may be a handbook, technical reports, or engineering periodicals.

Material published yearly in *Power*, if printed in book form, would require from eighteen to twenty volumes of standard size—a bookshelf in themselves.

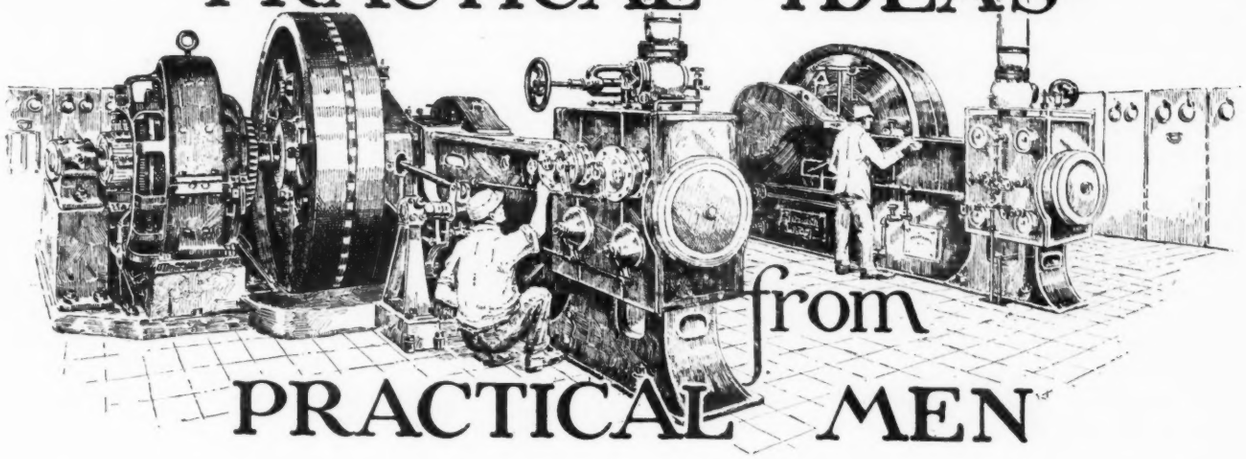
Many who wish to avoid the bulk of accumulated copies, keep a clipping file pertaining to the subjects with which they are concerned. This, of course, is the ideal plan. But many who do not have the time or inclination to keep such a file would find it helpful to retain or bind their copies and make full use of the semi-annual index.

Power's index for the second half of 1921 is now available and can be had free upon application. Send for it today.

Furnace volumes per square foot of boiler-heating surface have been increased very materially during recent years. Where one-tenth of a cubic foot of furnace volume, or less, per square foot of heating surface was general practice a few years ago, this has been increased to four-tenths or more for large boilers in present practice. Some of the figures given by T. B. Stillman in this issue, in an article "Boiler Capacities Obtainable per Cubic Foot of Furnace Volume," bring up the question, How far is it going to pay to increase furnace volumes? In one case approximately six hundred and sixty per cent of rating at a combined boiler and furnace efficiency of better than seventy-six per cent was obtained, with a furnace volume of less than one-tenth of a cubic foot per square foot of heating surface. This efficiency compares favorably with boilers having furnace volumes of four-tenths to five-tenths per square foot of heating surface and operating at two-hundred per cent of normal rating.

Among advertising men Thomas Edison is looked up to as the premier press agent. Now, however, Mr. Edison had better look to his laurels, for his friend Henry Ford is close at his heels. Mr. Ford's versatility seems unlimited, and the newspapers are devoting columns and columns to his many activities. He is fairly well known as an automobile manufacturer; for a while he dabbled in international politics, though without his usual success; he runs a newspaper; he has put up at River Rouge a plant with the world's largest boilers; he has bought a railroad and is operating it according to his own unusual ideas; he has offered to take over the Muscle Shoals project, which has apparently been too big for anyone else to attempt; and the latest story is that he plans to build a city seventy-five miles long in connection with the Muscle Shoals development. A detail of this plan is that farmers shall develop power from every brook and stream crossing their property.

PRACTICAL IDEAS from PRACTICAL MEN



Governor Caused Lights to Flicker

Following is an experience I had in one of the large New York hotels several years ago. I had installed four engines that were direct-connected to generators furnished by another contractor. When we got the first unit in operation, a decided flicker developed in the lights after the unit was in service a few hours, and it was soon discovered that the flicker disappeared when the temperature of the room was below 110 deg., but the temperature frequently ran up as high as 136 deg. The hotel management complained, and I advised them to get after the electrical contractor, which they did. The contractor put experts on the job and spent a couple of days testing the generator and finally decided that there was nothing wrong with it and that the trouble was in the engine.

After a careful examination of the governor I discovered that the trouble was in a gun-metal bushing in the main governor arm, which swung on a big pin that had a head on one end and was threaded on the other. The threaded portion was reduced in diameter so as to form a shoulder, and this shoulder was supposed to be the proper distance from the head of the pin to permit the governor arm to swing freely when the shoulder was drawn up tight on the boss on the spoke of the flywheel through which the pin passed; but this had been too close a fit, and evidently the gun metal expanded more than the steel, which accounted for the flicker appearing only when the temperature was above 110 deg. The trouble was overcome by placing a thin washer on the pin between the shoulder and the spoke.

Woodhaven, N. Y. FRANK F. REDDING.

An Experience with a Green Fireman

The following experience happened in a steam plant, used as an auxiliary to a hydro-electric station. No regular men were kept on hand to do the firing, and in case of an emergency such as anchor ice or low water, or because of other reasons the engineer, who did duty as operator of the hydro end as well as engineer, did the firing, the chief taking his place until someone could be procured to do the firing. There were several men around town who could fill in, in case of need.

On one occasion when the necessity arose to run the steam plant, none of the men who were ordinarily employed was available, but a young chap happened along who claimed to have had considerable experience as a fireman and he was put to work. The engineer noticed that he was somewhat nervous when shown what his duties were to be, and he spoke to the chief about it, but as no one else could be procured, the chief told the engineer to keep a close watch of him to see that he got along all right, as he might work into the job in time, and that anyone on starting a new job was likely to be uneasy.

With a little coaching the new man got through the first day without trouble, as the boilers steamed easily and there was not much of a load on the engine. But on the second day things began to happen. A chip got under the suction valves of the feed pump and of course prevented it from delivering water to the boiler, and when he noticed the water going down in the gage glass, he speeded up the pump, thinking it was not going fast enough. The next thing he knew the water was just going out of sight in the glass. Not knowing what the matter was, he called the engineer, who started the injector and got the water back to its normal level.

No doubt the water going down in the boiler had something to do with the way he acted during what followed, as he was getting somewhat nervous by this time. The engineer was working on the feed pump, getting it back in commission, when a gage glass on one of the boilers blew out, making quite a loud report accompanied by a roar of steam and hot water.

The fireman was just firing up and had a shovelful of coal on its way to the furnace. The report of the glass breaking, accompanied by the roar of steam and hot water and some of the hot water landing on the back of his neck, decided him that discretion was the better part of valor, and dropping the shovel, he did not hesitate as to his order of going, and an open window being the nearest way out he went head first, leaving the engineer to his own devices. The latter, on seeing what was going on, shut off the gage cocks. After the noise stopped, the fireman came back for his coat, stating that he was through.

The engineer told him that he had decided on that when he saw him go out through the window, as no one could leave him in the lurch the way he did and get away with it.

Upon being asked why he acted as he did, he acknowledged that his only experience had been firing a donkey engine, and as the boilers were similar in type, he thought that if he could hold onto the job for awhile he would become sufficiently familiar with them

to get by all right. What got his goat was the gage glass breaking. That was totally unexpected and unlooked for, as the donkey boiler that he was used to did not have a glass, using instead gage cocks to ascertain the water level, and thinking, when the glass broke, that the boiler was going up, he did not propose to be caught in the ensuing catastrophe.

Fairfield, Me. LEON L. POLLARD.

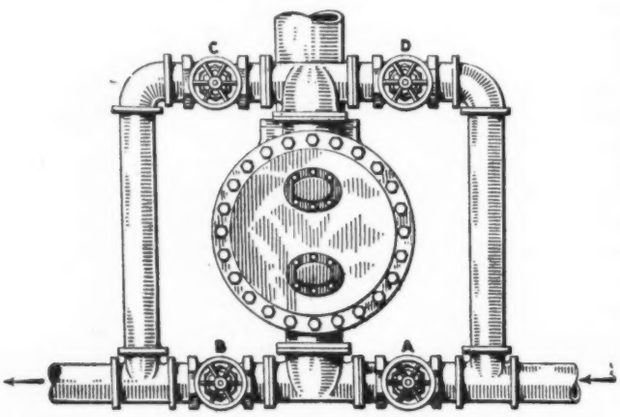
Reversing Flow of Condenser Circulating Water

A surface condenser attached to a cross-compound engine was constantly giving trouble on account of scaling of the tubes. The circulating water, drawn from an artesian well, was heavily impregnated with mineral water in solution. This was deposited so rapidly upon the hot surfaces of the condenser as to cause an almost complete stoppage of the flow through the tubes in the course of a few days' run.

Every Sunday morning the condenser was opened up and the tubes were bored out. Then, when the plant was started on Monday morning, the vacuum gage would register about 27 in. But the degree of vacuum would gradually dwindle as the week advanced until, when Saturday came, there would be scarcely any vacuum at all.

The engineer observed that the scale was formed in greatest abundance at the ends at which the water entered the tubes, there being an almost negligible quantity at the opposite ends. This gave him the idea that if he were to alternate the direction of the flow through the tubes at frequent intervals, the scale that would be formed at the entering end during one interval might be dislodged and washed out by the reversed current during the next interval. Accordingly, he cross-connected the circulating-water supply and discharge, as shown in the sketch.

The device worked splendidly. During one day's run the water would be supplied to the bottom of the condenser and taken out at the top, by opening valves *A* and *C* and closing valves *B* and *D*. Then, during the next day's run the flow would be reversed, entering at the top and leaving at the bottom by opening valves *B* and *D* and closing valves *A* and *C*. With this arrangement a vacuum of about 26 or 27 in. was maintained at all times.



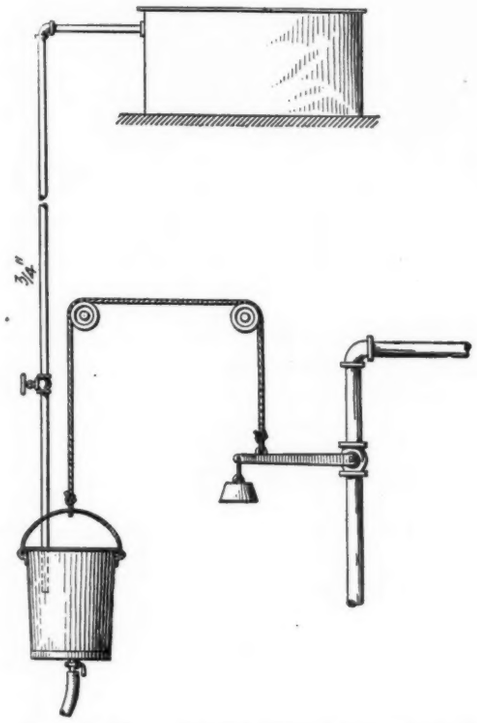
PIPING FOR REVERSING CIRCULATING WATER FLOW THROUGH CONDENSER

A. J. DIXON.

St. Louis, Mo.

A Home-Made Pump Regulator

Because of parsimoniousness or bullheadedness, some plant owners neglect to supply proper equipment for the economical operation of their steam plants. I have in mind a hotel in New York City that got its water supply for the roof tank from a driven well. The manager refused to purchase a pump regulator, claiming that it was unnecessary, as the water did not cost anything, and that if the tank did overflow there was no loss. He did not take into consideration the fact that it cost money to pump the water to the roof. Consequently, the pump was operated more or less by guess, the engineer having to make numerous trips nearly the whole length of the building, to listen at the leader pipe to detect if the tank was overflowing. He finally constructed the device illustrated in the sketch. It was not original with him; however, it may be new to some readers.



HOW THE PUMP REGULATOR WAS ARRANGED TO STOP THE PUMP AUTOMATICALLY

A ¾-in. pipe was connected to the tank about an inch below the regular overflow pipe. This was brought down the pipe shaft to a point near the pump, and into a galvanized-iron pail that hung on a wire cable leading over two pulleys to a lever valve on the pump steam pipe. A valve was placed in the ¾-in. overflow pipe and throttled down to prevent a sudden rush of water into the pail. A ¼-in. cock was soldered in the bottom of the pail, and set to allow the pail to empty in a given time. A weight was attached to the throttle lever, to open the steam valve, and start the pump when the pail was empty.

This device worked satisfactorily and its crude appearance later shamed the manager into purchasing a proper pump regulator which, of course, operated much better.

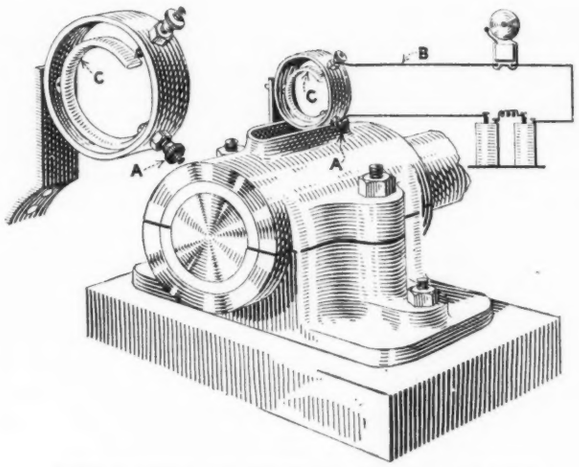
M. M. BROWN.

Camden, Me.

Thermostat Bearing Alarm

In one instance I had a bearing that was difficult as well as dangerous to get at, and it caused some uneasiness at times as to whether it was or was not heating. As a partial safeguard at least, a thermostatic alarm was rigged up as shown by the illustration.

The terminal *A* for one end of the wire *B* is also connected to the bent tube of the thermostat *C*. This



APPLICATION OF THERMOSTAT TO BEARING

tube tends to straighten with an increase in temperature and in so doing comes in contact with the other terminal, establishing a circuit through the bell when a predetermined temperature is reached in the bearing.

Jersey City, N. J. JAMES BROWN.

Applying Two Motors to the Same Mechanical Load

Two similar direct-current motors may be successfully operated in parallel to drive the same load from a single controller, provided their pulley or gear reductions are such as to drive the load at the same speed. In special cases where a motor of proper voltage rating has been unavailable, two motors of half the line voltage rating have been connected in series and operated from a single controller, as if they were a single motor of proper voltage rating. Where motors are to be operated in series, it is necessary to connect them to the same load, otherwise their speeds will be unstable and one of the motors may even stop. This will cause full-line voltage to be applied across the running motor, which will attain a dangerous speed.

With squirrel-cage-type alternating-current motors, aside from the motor ratings and speed requirements, no special precautions need be observed when it is purposed to operate two motors from the same compensator, especially if the motors are to drive the same mechanical load. When they drive different mechanical loads, the motors may be started one at a time. In some cases a number of motor connections have been arranged to start each motor individually from the same compensator. In this case a double-pole switch is used to connect the motor to the compensator for starting, and after it has been brought up to speed the switch is thrown over to connect the motor directly to the line.

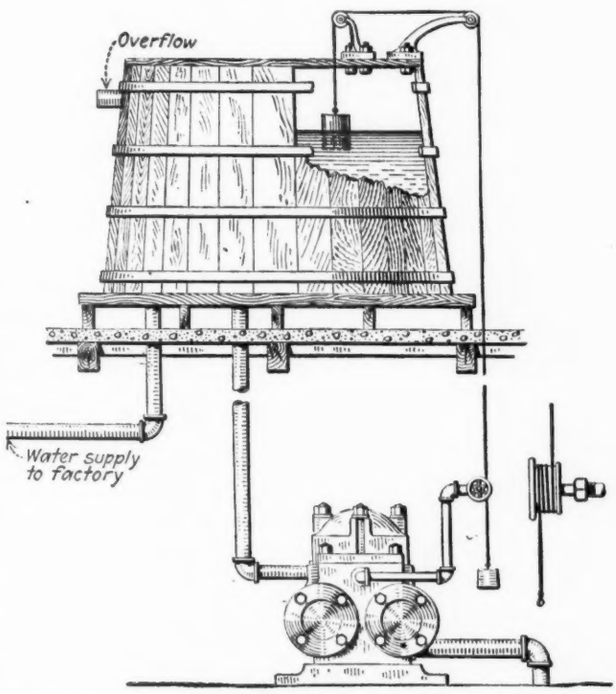
Where slip-ring motors are to be applied to the same load and operated from the same controller, there arises a condition that must be observed, otherwise the blowing of fuses may render operation entirely impracticable. Since each rotor generates a voltage, they are similar to two alternating-current generators and must be treated as such when connected in parallel. The rotors will have to be phased out and connected together, in the same way that two alternators must be when driven by the same prime mover. After the proper rotor positions have been located, they must be permanently connected together mechanically, otherwise they may get out of phase during starting and will produce a condition similar to connecting two alternators in parallel out of phase. Heavy currents could circulate between the two rotors without going through the starting resistance. Unless it is necessary, it will be found a good practice not to try starting two such motors in parallel from the same controller, since they will require careful adjustments for satisfactory starting.

E. C. PARHAM.

Brooklyn, N. Y.

Starting and Stopping Rig for Tank Pump

Almost every engineer has lived through the experience of overrunning the roof water tank, to say nothing of a tank placed inside of a tower. An experience with the latter kind of tank caused me to rig up a stopping and starting device for the house pump in a plant I ran



HOUSE-TANK PUMP STARTED AND STOPPED BY A FLOAT AND WEIGHT

some years ago. This tank was in a tower directly over the factory office. One day the pump was allowed to run overtime and overflowed the tank, flooding the office and contents, not to mention its effect on the temper of the office force.

To prevent a second occurrence, I rigged up the arrangement shown by the illustration. A float was placed in the tank and a suitable cord run from it over pulleys to the throttle valve of the pump, winding around a spool attached to the valve wheel. A weight cord was

also wound around the spool several turns, so that as the float lifted in the tank, the weight would close the valve. As the water lowered, the weight of the float overcame that on the valve stem and the valve was opened, thus starting up the pump.

There was one objection to this rig in that considerable wiredrawing of steam past the valve seat and disk occurred and considerable condensation took place in the steam cylinder of the pump as a result. Some sort of a quick opening and closing valve would have been better, but such was never rigged up. Perhaps some reader may have a better arrangement. P. D. CASEY.

Reading, Pa.

His First Plant and What Happened

I landed my first engineer's job in answer to the following advertisement: "Engineer wanted; good steady man for factory. Bring references. Salary, $20 per week." As I was leaving to take this job my chief said, "Now go to it, son, and if you should get in any trouble and need help or advice, call on me."

On taking charge of my new plant, I found it shut down on account of alterations being made in the factory. This gave me about a month to get two return-tubular boilers, a Corliss engine and a few pumps in running order. The boilers were cleaned internally and externally. The fireman, an old-timer, told me that nearly all the valves on the main steam lines were leaking badly. They were reseated and new discs put in.

Two automatic non-return stop valves were found stuck tight in the open position. Rather than take a chance of breaking anything, about a gallon of kerosene was poured into both valve dashpots and left until morning. After a careful study of the subject that night, I learned that there were supposed to be ports in those valves between the steam space at the top of the valve, which acted the part of a dashpot, and the steam space underneath which acted as a cushion to prevent pounding or hammering as the valve closes. The next morning as the fireman was cleaning the valves, he discovered a small port hole filled with scale. This was the port the book had mentioned and both valves were soon working perfectly.

When the boilers were finally fired and carrying about 50 lb. pressure, about one-half the tubes were found to be leaking at their centers and the boilers had to be retubed. These leaks did not show before they were cleaned on account of the scale covering the holes.

Next, I tackled my first Corliss engine with a prayer that it would run when steam was turned on. Having duly warmed up the engine, it was hooked up, the throttle valve was cracked and away went the engine acting like a bucking bronco, the crank-end valve working fine, but the head-end valve cutting off almost before steam was admitted, making the crank-end do the work.

My old chief was visited that night and he had a good laugh at me. He put on his hat and coat, and off he went to my Corliss engine. Upon arriving at the plant, he assumed full charge of operations. He blocked the governor in approximately the center of its vertical travel, hooked up the valve gear in the running position, and then measured the point of cutoff for each end of the cylinder by turning the engine over by hand. Next he let out a few cusses and showed me that the cutoff cam had been shifted on the head-end valve, so that the valve closed altogether too soon. It took but a minute to put the cam back to its old position.

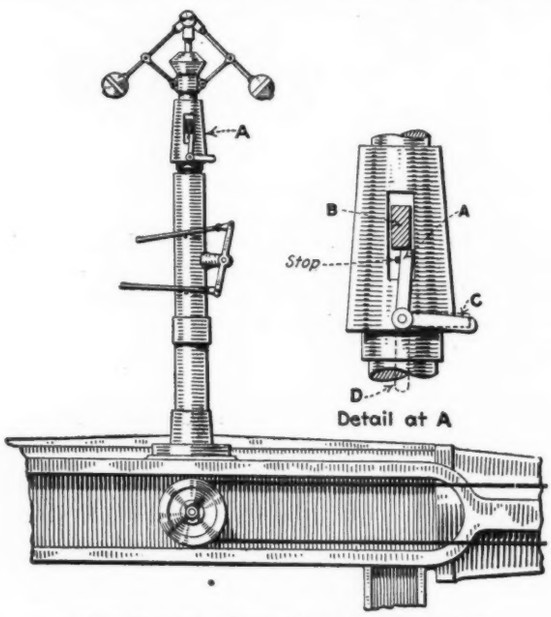
The chief then opened the throttle just enough to turn the engine about 25 r.p.m., and what a changed engine! Corliss valve gears were later given a lot of my spare time, but the lessons I had already learned stuck, and my first position as engineer was successfully under way.

New York City. M. J. MURPHY.

Corliss-Engine Safety Stop

After narrowly averting a wreck by a runaway engine because the safety pin had not been removed after starting up, the engineer decided that it was about time to arrange a stop that was automatic and not dependent on the human element for its operation. He finally made a stop about as shown by the illustration. It consisted of a bell crank to take the place of the original pin. It was pivoted on the governor stand so that the end *A* would bear against the crossarm *B* of the governor when it was in its starting position.

Upon starting the engine and getting up to a speed sufficient to lift the governor arm from the stop, the



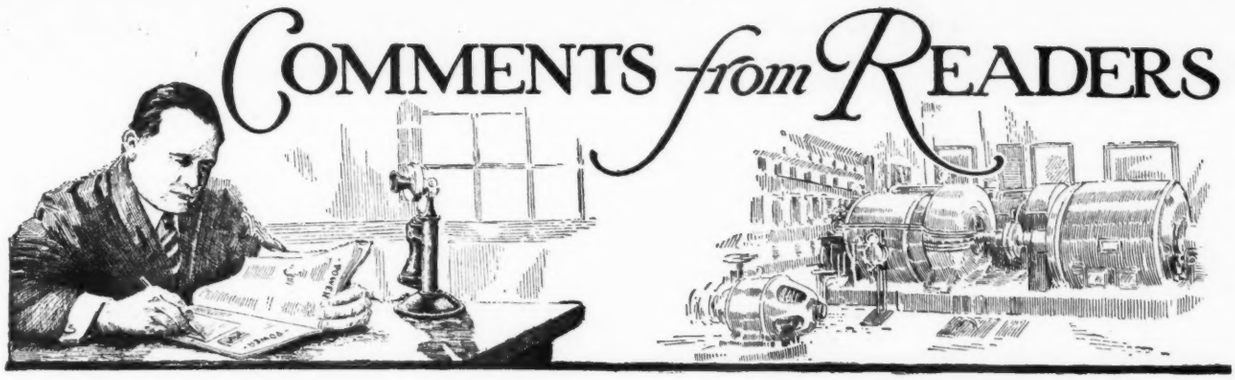
DETAILS OF GOVERNOR SAFETY STOP

weight arm *C* falls to the position shown by the dotted lines *D* and the arm *A* is carried away from the arm *B*. When in the position of the dotted lines, the governor is free to drop to its lowest possible position in case of the governor belt breaking which action brings the valve knockoff blocks to a position that will prevent the valve picking up, thus shutting down the engine. Of course the stop must be set in the position shown upon shutting down; otherwise the valves will not hook on.

This device, while probably not new, is a safeguard against leaving the safety in position, which is a common practice with some engineers, who operate engines having fluctuating load, so as to prevent the engine stopping with a sudden heavy increase in load.

I visited an engine room one day and during a conversation with the engineer he mentioned that the engineer who had run the plant while he was on his vacation generally forgot to remove the pin from the governor. Later on I observed this engineer slyly remove the pin, which he had forgotten, while I discreetly looked the other way. P. H. HARRIS.

Cleveland, Ohio.



Valves in Water-Column Connections

Regarding the question of closed valves in water-column connections being a danger, could not anyone, if so inclined, do the same thing with the water-glass cocks—leave the blowoff cock part way open, close the cock under the steam gage or screw down the safety valve so that it would not blow off the steam until a dangerous pressure was present? As a matter of fact is there any so-called safety device that cannot be made inoperative by an incompetent, careless or malicious person? This, however, is no reason for discontinuing the use of safety devices.

Regarding valves in water-column connections the top valve can be an angle or gate, as it will not become closed with scale or sediment if the column is sometimes blown out. With the bottom valve it is different, as it should be blown out at least once a day, or more often with dirty water. The bottom valve should be a straight-way connected to the straight pipe between the column and the boiler, a cross fitting being placed on the pipe under the column, the blowoff valve being attached to the under connection and a plug with graphited threads screwed into the outer opening. Should the bottom pipe become closed or nearly closed, the column valve can be closed, the plug removed, and using an iron rod bent at right angles to prevent a shutdown, by opening the valve and forcing the rod through the collected scale. As soon as an opening is made, the rod is withdrawn, the valve closed, the plug screwed into place and the two valves opened.

The valves can be either locked open or the handles removed and the square end sawed from the stem of each or leaving only the round stem, which will require a pair of pliers or a small pipe wrench to turn; thus they cannot be closed by accident. JAMES E. NOBLE.

Portsmouth, Canada.

At one of our boiler plants there are six large water-tube boilers, working at 160 lb. pressure, which have been in use about twenty years. During this time there never were any valves between the water column and the boiler nor were any wanted.

It has been proved that they are a dangerous thing on a boiler and I give the following reasons: There are times when such valves have been closed by someone, and that someone forgot to open them again, and many boilers have been ruined from this cause; the disks have become loose and dropped off the stem, with serious result, and if these valves are not opened and closed every day or so, they will corrode or scale will form on them, so that when they are needed they are found to be of no use. Every boiler that is working up to its full capacity day and night, should be closed down at least every six weeks and looked over. My experience shows that flange joints, made with a good grade of sheet packing and properly followed up will not blow out. Water gages and gage cocks that will stand a run of six weeks or longer without any attention are easily obtainable.

My advice is, not to attach any appliance to a boiler that is considered dangerous. Do not use any fitting or appliance that is not suitable for the working pressure of the boiler. This means "safety first." Then there will be no split water columns, leaky gages or gage cocks, and valves between the water column will not be a necessity or a convenience. THOMAS J. PASCOE.

Norway, Mich.

Removing Static Electricity from Belts

I noticed that the readers of *Power* are still offering suggestions to Mr. Peterson, who asked on page 651 of the Oct. 25, 1921, issue how to remove static electricity from belts. None of the remedies given will remove the static completely, as has been found from similar experiences and tests.

At one time I operated an 1,800-volt generator and at times would get a static shock from the field frame or belt which would naturally give me a scare due to my mind being on the danger of the voltage generated. I got one shock from the machine frame that knocked me out for several minutes. It was found that the only way to remove the static electricity completely was to have a piece of plumber's chain always dangling in contact with the inside of the belt, close to the generator where the belt leaves contact with the pulley. The other end of the chain should be grounded to a water or steam pipe. If Mr. Peterson will try this stunt, I think his static troubles will be over. W. T. MEINGER.

Brooklyn, N. Y.

[If Mr. Meinger obtained static shocks from the frame of the machine, then the frame must have been insulated from ground, a practice which is exceedingly dangerous. Should a ground occur out on the system and the winding become grounded to the machine's frame, then if anyone were to touch a grounded object and at the same time come in contact with the frame of the machine, he would be shocked with a potential varying from near zero to the full voltage of the machine, in this case, from 0 to 1,800 volts. A shock from the higher voltages is likely to result in death. Where the voltage is higher than 150 volts, the National Electrical Code requires that the frame of all machines be permanently grounded wherever possible. But aside from the code requirements any machine operating on 500 volts and above should have its frame grounded for safety sake, if for no other reason.—Editor.]

The Load on an Engine

In his letter under the heading "The Load on an Engine," page 855 of the Nov. 29 issue, W. H. Wakeman makes some errors in reasoning which are likely to be misleading. Referring to Fig. 1, he gives the average pressure in space *B* as 60 lb., and with a "horsepower constant" of 10, figures 600 hp. developed for useful work. Similarly, with an average pressure of

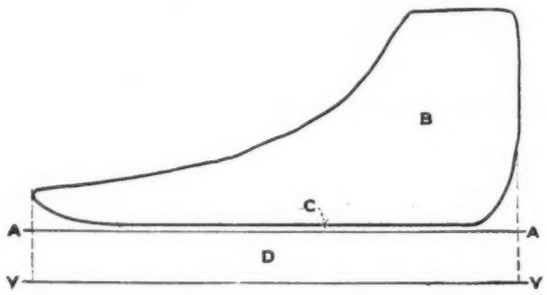


FIG. 1. DIAGRAM OF ENGINE OPERATING WITH HEATING SYSTEM

5 lb. between the back-pressure line of the diagram and the atmospheric line he gets 50 hp. required to overcome the resistance of the heating system, and finally with 15 lb. pressure from the atmospheric line to the absolute zero line, 150 hp. to overcome the resistance of the atmosphere. He, therefore, claims that the engine has a total load of 800 horsepower.

Allowing for the moment that this is correct, let us consider Fig. 2. Here the effect of the heating system is eliminated and the back-pressure line (for the most part) coincides with the atmospheric line. From the diagrams as published, the forward stroke lines seem to be the same in both cases. Therefore the average pressure in space *B* would be greater than 60 lb. or (neglecting the small space at the toe and heel of the diagrams) 65 lb., giving 650 hp. This simply means that the 50 hp. formerly represented between the back-pressure and atmospheric lines is now included in the space *B*. In the same way, in Fig. 3, dropping the back-pressure line below the atmosphere simply transfers more of the work to the space *B*. Therefore, if Mr.

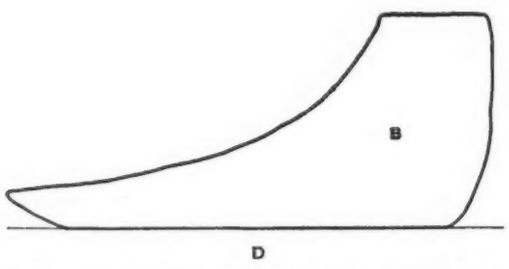


FIG. 2. DIAGRAM OF ENGINE EXHAUSTING TO ATMOSPHERE

Wakeman's first computation of 800 hp. is correct, Fig. 2 and Fig. 3 also show 800 horsepower.

Going back now to Fig. 1, consider the question of the amount of coal required. Since we are considering the engine only and not the boiler, the amount of coal will depend only on the amount of steam used, and it is simpler to consider steam quantities instead of coal quantities. The diagram shown indicates a certain steam-line pressure and a certain point of cutoff. Assuming no cylinder condensation, this gives a definite weight of steam admitted to the cylinder. With the back-pressure line as indicated in Fig. 1, 600 hp. is developed with this quantity of steam. Conditions as indicated in Figs. 2 and 3 indicate 650 and 770 hp. respectively, developed with the same quantity of steam. This of course means more horsepower per pound of steam in the case of Fig. 3 than Fig. 2 and more in Fig. 2 than in Fig. 1. If only 600 hp. is required in any case, cutoff must be shortened for the back pressure in Fig. 2 and still more so for Fig. 3. This means less steam for the same horsepower, which amounts to the same thing as more horsepower from the same amount of steam.

In the actual engine the cylinder condensation modifies this slightly. Condensation of the entering steam results in a greater weight entering the cylinder before cutoff. Lowering the back pressure lowers the exhaust temperature and therefore increases initial condensation. At a given cutoff, therefore, a lower back pressure results in an increase in the total weight of steam admitted. While this will not change the amount of power developed, it will increase the steam required per horsepower over that necessary under the assumption that no cylinder condensation takes place. Experiment shows, however, that (up to a certain point) the

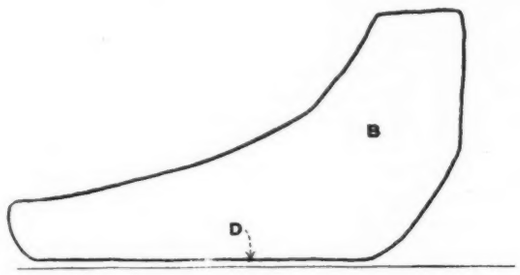


FIG. 3. DIAGRAM OF ENGINE RUNNING CONDENSING

gain in power by lower back pressure is greater than the loss due to the accompanying increase in cylinder condensation.

As Mr. Wakeman says, "not all the fine points involved are mentioned here," but it is hoped that this will help to correct any mistaken ideas that may have been formed from a hurried reading of his article.

Boston, Mass. DEWITT M. TAYLOR.

Boiler Explosion at Mechanicsville, N. Y.

Yesterday I talked with a boiler inspector who had been to Mechanicsville to investigate the recent explosion, and he said that the manhole ring was made of cast iron. If that is so, there is no further mystery as to the cause of the explosion. I asked him if they had other boilers with cast-iron rings, and he said, "Yes, and there are a good many about the country."

He said that when cast-iron rings are used, the holes are cored in the foundry, and the holes in the plate are punched to the proper position, and if they do not match the cored holes, they are drifted into place. In all probability the rivets do not fit the holes in either the plate or the ring. I do not remember seeing anything in the Boiler Code prohibiting the use of cast-iron rings, but did not suppose that anybody was making them or that there were any more in use. F. W. DEAN.

Boston, Mass.

Water in Steam-Engine Cylinders

After reading the article "Water in the Steam-Engine Cylinder," by I. L. Kentish-Rankin, in the Dec. 27, 1921, issue of *Power*, I was disappointed that he had not considered the barometric type of condenser. This type has been giving some engineers who are up for their second-class engineer's license in Massachusetts considerable trouble over the question, "Can water come back into the cylinder if a barometric condenser is used?" Also, "Can it come back if a 1-in. hole is drilled in the tail pipe 6 or 20 ft. above the hotwell overflow?"

Engineers differ as to whether an engine cylinder can be flooded by a barometric condenser. There is no doubt in my mind that if the condenser is airtight and has a 34-ft. vertical height above the overflow of the hotwell, no water can find its way into the cylinder if the water is siphoned in.

We will consider a condenser with a tail piece 34 in. high, vacuum 26 in., injection water raised 20 ft. and a 1-in. hole drilled 6 ft. above the hotwell in the tail pipe. I do not believe that this 1-in. hole will affect the vacuum materially, because the air entering this hole will have to mingle with the water in the standpipe, and it will therefore have a difficult passage up to the condenser head. The water in the standpipe is constantly falling down and would tend to expel this air from the condenser. But if the hole is 20 ft. up, the air will mingle with the water more freely, and I consider that the engine can be flooded with a hole at this point under certain conditions; for instance, when shutting down with a vacuum back to the piston.

I saw a letter about three years ago from a condenser manufacturer, stating that upon tests in drilling 1-in. holes into the tail pipe at the higher points, the water would go over into the engine.

The reason for this evidently is that the atmospheric pressure acts on the water through these holes, and there will be a tendency to hold the water up higher. The theory of this is that the atmospheric pressure and the vacuum are in the same ratio all the way up; for example, at about 17 ft. the vacuum would be 15 in., while the pressure of the atmosphere is 7.35 pounds.

What have the other engineers to say about this?

Springfield, Mass. F. C. EATON.

Compensating Pressure Gages for Error Due to Water Columns

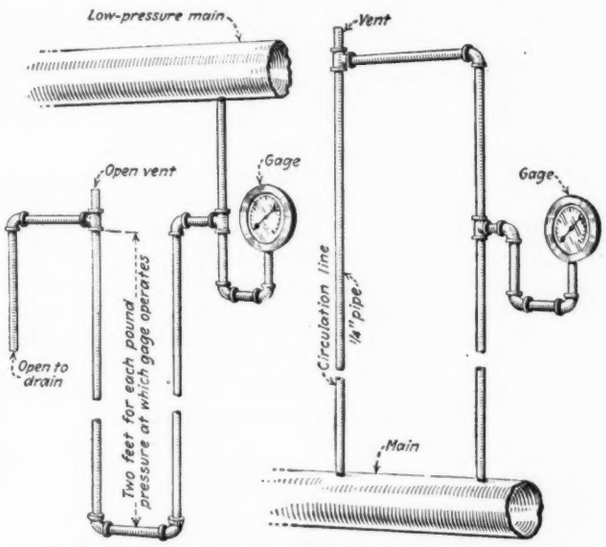
On page 1027 of the issue of Dec. 27, 1921, W. J. Meinzer gave the illustration reproduced here and stated that there would be a circulation through the gage pipes and that this circulation would counteract the effect of the water column and thus give a true reading on the gage. He does not state whether his arrangement can be used on steam or water, or both, nor with what pressure it would be practicable. As a matter of fact both plans would probably work out for a water system operating at about 5 lb. pressure, but even at this pressure the U-tubes would have to be over 11 ft. in length. In the average plant there is not any too much headroom for piping of this nature.

Neither arrangement would work with a steam pressure as the steam would soon drive all the water out and would then escape to the air through the vent. When this happened, the gage would give a reading much lower than the pressure in the mains, and this reading would be worthless.

To sum up these criticisms, Mr. Meinzer's arrangement would not be applicable to steam at any pressure and only on water systems of an extremely small pressure such as seldom found.

I have used the following plan with success: Every gage-line water column is measured and the head in feet multiplied by the constant 2.306. This gives the head in pounds per square inch, or the amount of gage correction.

A record is kept of these corrections, and when a gage is checked, it is set high or low according to whether



GAGE PIPING RECOMMENDED BY MR. MEINZER

the gage is above or below the header and according to the amount of correction. By keeping an index of these corrections and correcting the gages in this way, the discrepancies caused by water columns may be overcome. JOHN T. WEST.

Allentown, Pa.

Explosions in Open Feed-Water Heaters

R. Miller, on page 984 of the Dec. 20, 1921, issue of *Power*, asks as to the cause of explosions in the heater. He states that a gage glass at the tank showed a rise and fall of the water, and that when the water fell there was an explosion in the heater.

I believe the answer to this is that when the water in the tank rose there was a stoppage of the delivery to the heater, due to an accumulation of air that the air trap did not eliminate. When such delivery stopped, the water in the line from the tank to the heater ran back into the heater, allowing the exhaust to follow into the heater end of said pipe. Then when the water fell in the tank, showing that a discharge was taking place to the heater, it caused a water hammer. The installation of the check valve in the line prevented a reversal of the flow of water keeping the delivery pipe sealed.

At times an open heater will hammer terrifically when there is a leak in the internal water seal which is allowing the exhaust to work backwards into the water line. This is particularly noticeable where the water supply is of a pulsating nature. JOHN F. HURST

Louisville, Ky.

QUESTIONS AND ANSWERS

Heat Radiated from Boilers

In boiler practice what percentage of heat is lost by radiation to the atmosphere? E. B.

The losses by direct radiation vary with the kind and size of boilers, the percentage of rated capacities at which they are operated and the surrounding air temperatures to which the boilers are exposed. Radiation loss usually amounts to 12 to 15 per cent for small boilers operated at low rates, 7 to 8 per cent for fair-sized units at average loads and 2 to 3 per cent for very large boilers operated at high percentages of rating.

Clinkers on Furnace Firebrick

How can we prevent accumulations of slag and clinker on the firebrick of our hand-fired boiler furnace along the sides of the grate? G. N. H.

The clinkers are built up from fused earthy matter contained in the coal or that has become mixed with the coal. The best remedy for prevention of accumulations of clinkers is to take especial care in keeping the fire bed clean along the furnace side walls. The accumulations usually can be broken up and loosened from the brickwork by covering the clinker with several layers of oyster shells or broken limestone and carrying a thick and hot fire on the grates.

Allowable Acidity of Lubricating Oil

How can it be known when the acidity of a lubricating oil reaches the danger point? R. N.

The maximum limit of acidity cannot be definitely fixed. Generally speaking, the acidity of the oil increases slowly with use, and the oil will be perfectly satisfactory for a long time. When the rate of increase in acidity goes up rapidly, it is a sign that the oil is approaching the end of its useful life of service. Samples should be secured and regularly analyzed, and the properties on successive tests compared. When the properties begin to change in value rapidly, it is time to change the oil.

Data for Calculating Duty of Refrigeration Plant

What data must be obtained in order to calculate the theoretical refrigeration duty secured in a refrigeration plant? J. G. S.

Take an indicator card from the compressor or two or three of them, during any given time, say over a half-hour period, and obtain the following information: (1) Speed of the engine per minute; (2) length of test; (3) pressure of the suction elbow; (4) temperature in degrees Fahrenheit at suction elbow; (5) discharge pressure at the discharge elbow; (6) temperature of discharge vapor at the discharge elbow; (7) temperature of the liquid in the receiver; (8) if possible, temperature at the outlet of the coal.

If two suction pressures are carried and one of these suction pressures is connected to the head end and the other to the crank end of the cylinder, it will be necessary to obtain data on both. Then a close estimate can be made of the refrigerating output. However, it must be remembered that this will be based on calculations that may be wrong, due to leakage in the cylinder and variations in the volumetric efficiency of the cylinder. The best way to find the refrigerating duty secured from a plant is to weigh the brine which is being cooled by the ammonia, for by that method the actual duty is ascertained.

Setting Valves of Double-Eccentric Corliss Engine

What is the method of setting the valves of a double-eccentric Corliss engine? G. R. C.

Upon removing the back bonnets from the valves, a mark made by the engine builder will be found on each valve corresponding with the opening edge of the valve, and upon the seat, or the bottom of the valve chamber, will be found another mark corresponding to the opening edge of the port. The correctness of a mark can be verified by placing a straight-edge along the port.

See whether the dashpot rods are sufficiently shortened to prevent the pistons from striking them when the engine is turned over. Roll the eccentrics over and observe whether each rocker arm swings an equal distance each side of a plumbline held in front of its fulcrum pin, and if not, equalize the motions by adjusting the lengths of the eccentric rods. Next see that the central mark on each wristplate swings an equal distance each side of the middle mark on the wristplate hub by adjustment of the lengths of the reach rods from the rocker arms to the wristplates. If there is no such adjustment for either wristplate, it must be made to swing equally to either side of the center marks by adjusting the length of its eccentric rod.

Next detach both of the reach rods and, with the governor on the stop-motion pin or collar, place the wristplates in middle position, with the center lines on the stud and wristplates coinciding, and with the steam valves hooked on, lengthen or shorten the valve rods with rights and lefts to the steam and exhaust valves so the edges of all valves will be in line with their ports. Reconnect the reach rods with the wristplates, place the engine on a dead center, hook on the valves, and roll the steam eccentric on the shaft ahead of the crank in the direction the engine is to run, until the valve that should admit steam begins to open. Then secure the steam eccentric, place the engine on the other center, and if the

steam valve of that end is not line on line with its port, adjust it to that position with the right and left of the rod to that valve. To set the exhaust eccentric, place the piston at about ⅞ stroke and advance the exhaust eccentric until the exhaust valve on the end the piston is approaching is just beginning to close.

After fastening the exhaust eccentric, turn the engine over in the running direction until ⅞ of the opposite stroke is completed and note whether the exhaust valve is just closing; if not, bring the valve to the closing position by adjusting the length of the valve rod. Adjust the length of the dashpot rods by putting the steam valve wristplate at the extreme travel first to one side and then the other and adjust each rod length until the hook or crab claw just engages and clears the block about 1/16 in.

If greater range of cutoff is desired than ½ stroke, the steam eccentric must be set back of the 90-deg. position and the lead adjusted by the valve rods, giving negative lap when the wristplate is in central position. If set much back of 90 deg., the governor must be blocked in stopping so that in starting the cutoff will trip at the extreme range and not depend on positive cutoff at full stroke. To equalize the cutoffs, block the governor at the average running position, when the reach-rod lever should stand about at right angles to the reach rod or where there are two rods about at right angles to a line drawn midway between the rods. Then place the piston at about ⅓ stroke from the crank end and adjust the governor reach rod to the valve on that end so the valve will be just tripped with the engine in that position.

Now place the piston at the same length of stroke from the head end and adjust the length of reach rod to obtain tripping of the valve at that end. When the cutoffs are equalized, drop the governor to its lowest point and set the safety cams so they will prevent the valves from being picked up before the port is uncovered, but not so low that the valves may not be picked up when the governor is on the starting pin or collar. Also block up the governor to its highest position and see that the valves are not opened for that position which would result from overspeeding of the engine in case of sudden loss of the load.

Iron-Body Plug Cocks

For use with pressures below 10 lb. per sq.in., what is the objection to construction of plug cocks with brass plugs and malleable iron bodies? W. C. C.

From dissimilarity of the metals the plugs and shells cannot be so readily ground together for making a tight joint as when both are made of the same material, and on account of the difference in coefficients of expansion, a brass plug set up tight in an iron body, or shell, would be very difficult to move after expanding more than the shell for an increase of temperature and would not be as tight for a lower temperature. Another objection to the use of dissimilar metals is that, when conditions are favorable to the corrosion of either of the metals, their disintegration is hastened by galvanic action.

Submerged-Piston and Straightway Pumps

What is the difference between a submerged-piston pump and a straightway pump? H. H.

Ordinary direct steam pumps have the suction and discharge valve decks above the pump cylinder, and a pump with the valve chambers thus located is known as a submerged piston pump. In a straightway pump, the suction valves are located in a valve deck underneath and the discharge valves are above the water cylinder, and the water flows through the pump in a practically unchanged direction. While the direction of flow is not absolutely straight, it is more nearly so than in the submerged-piston type. In the straightway type, when the piston comes to a stop at the end of the stroke, the water does not necessarily stop at the same instant, and owing to its inertia, may continue to flow through the pump for a short time; but in the submerged-piston pattern the piston, in reversing must overcome this tendency, bring the water to a full stop and reverse its direction.

How a Synchronous Motor Pulls into Step

Can an induction motor, which has the same number of poles as the generator that supplies the power, run at the same speed as the generator—that is, at synchronous speed—or must there necessarily be some slip even at no load? If the rotor of the induction motor must run slower than synchronous speed, how does a synchronous motor get into step when started as an induction motor? E. B.

In a polyphase induction motor the relation of the currents in the stator windings are such as to produce a revolving magnetic field. This field revolves at synchronous speed and is equal to 120 times the cycles per second divided by the number of poles. On a 60-cycle circuit the magnetic field of a four-pole motor will revolve at $(120 \times 60) \div 4 = 1{,}800$ r.p.m., and if the alternator supplying the power has four poles, it will also revolve at the same speed. If the rotor of the induction motor was revolved at 1,800 r.p.m., its conductors would be moving at the same rate as the stator's magnetic field. Under this condition the conductors would not be cutting any of the lines of force and therefore would not have a current induced in them; consequently, the rotor could not develop any turning effort. In order that the rotor conductors may cut the lines of force, it must run slower than the magnetic field. At no load the difference in speed will be small. At full load the rotor will run from 4 to 10 per cent slower than the stator's field, depending upon the resistance of the rotor's winding.

When a synchronous motor is started as an induction motor, it cannot pull into step until the field switch is closed. When the motor is started, the field switch is left open and the motor brought up to as near synchronous speed as it will come as an induction motor; then the field switch is closed and the motor pulls into step, provided it is not too heavily loaded. If the motor has a low-resistance squirrel-cage winding in the pole faces, it will not be capable of developing a good starting torque, but can bring the load that it can start up to near synchronous speed, therefore will pull into step easily when the field switch is closed. On the other hand, if the starting winding in the pole faces has a comparatively high resistance, the motor will develop a good torque, but the rotor will have considerably more slip than the low-resistance rotor. As a result the high-resistance rotor may not pull into step as smoothly as the low-resistance machine. In either case the field switch must be closed before the rotor can come up to synchronous speed.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Interpretations of the A. S. M. E. Boiler Code

REQUESTS for interpretations of the Boiler Code are acted upon by the Boiler Committee, their formulated replies being submitted to the Council of the American Society of Mechanical Engineers. The inquiries and replies are published from time to time in *Power*, with such explanatory comments and illustrations as seem advisable for a clear understanding of the interpretations on the part of engineers in general. The last group of interpretations published in *Power* was in the issue of Jan. 17, 1922.

Case No. 375—Inquiry: Is it permissible, under the requirements of the Boiler Code, to weld a seam in a vertical firebox not over 38 in. in diameter, and in length ranging from 20 in. up, by the autogenous or fusion process where the firebox has no support other than the tube sheet, mud ring and firedoor?

Reply: It is the opinion of the committee that, under the requirements of the Code, autogenous or fusion welding is not permissible for the seam in the firebox of a vertical-tubular boiler, unless the sheet containing the seam is supported by staybolting.

Case No. 376—Inquiry: An interpretation is requested of the limitation of 50 hp. in Par. 318 of the Boiler Code to different classes of boilers. Is it the intention that the horsepower capacity be based on water-heating surface as specified in the requirement in Par. 274?

Reply: It is the opinion of the committee that the intent of Par. 318, relative to the determination of the feeding devices required for boilers, will be met if boilers having over 500 sq.ft. of water-heating surface are provided with two or more feeding devices.

Paragraph 318 follows: "When a pump, inspirator or injector is required to supply feed water to a boiler plant of over 50 hp., more than one such appliance shall be provided."

Paragraph 274 gives the pounds of steam that shall be assumed to be evaporated per square foot of heating surface per hour, in determining the size of safety and other valves on a boiler.

The reply shows that horsepower, as used in Paragraph 274, has nothing to do with steaming capacity and is merely one-tenth of the heating surface.

New York State Water-Power Legislation

In response to the suggestions made by Governor Miller of New York in his recent annual message to the legislature, two bills were introduced Jan. 18 by Senator Robinson, dealing with water-power development.

One of these, Senate Print No. 211, comprising amendments to the conservation law, is by far the more important measure and the one that is likely to be the subject of the greatest difference of opinion. The first important amendment in this bill adds a new subdivision to section 613 of the conservation law, in relation to the powers of the commission, reading:

> Shall have the power and duty to fix and determine, after a hearing held upon notice to the parties interested, the amount of an equitable rental, which is hereby charged pursuant to the reservation made by Chapter 597 of the Laws of 1918, for the diversion, as specified in such chapter, of water from the Niagara River, and to sue for and collect in behalf of the state such rental as so fixed and determined.

This subdivision affects the interests of "any new corporation constituted by the consolidation of Cliff Electric Distributing Co., The Niagara Falls Power Co. and Hydraulic Power Co. of Niagara Falls and the successors and assigns of such new corporation."

A new section, No. 637, entitled "Previous grantees not to divert waters without license," is inserted to make certain the right and purpose of the state to prevent any corporation from having any claim to preferential rights under an old grant or charter and to make it clear that such a corporation must come under the provisions of the conservation law. Certain corporations have in the past assumed that with a previous grant by the state legislature, they were not subject to state supervision or regulation, and that with a Federal permit their rights to water power developed could not be assailed. The new section asserts the position of the state in emphatic terms:

> §637. A corporation claiming or purporting to have, or to have had, by general or special act or other grant from the state, the right to divert water from Lake Erie, Niagara River or the boundary waters of the state, or any waters in which the state has a proprietary interest, or the successor in interest of such a corporation, if there has not been and is not now an actual diversion of such waters and development of power therewith pursuant to such act or grant, may apply, *without preference* on account of such act or grant, for a license under this article to divert such waters, and shall not divert such waters without having obtained such license, and shall otherwise be subject to the provisions of this article.

The corporations and their successors and assigns affected by this section are the Niagara County Irrigation and Water Supply Co., the Model Town Co., the Niagara, Lockport & Ontario Power Co., and the Lower Niagara Power and Water Supply Co.

It will be noted that the amendment to section 613 gives the state the right to collect back rental for waters diverted in Niagara River and that the new section 637 compels all Niagara companies to make application without preference on the same basis as any other individual.

In all probability, a bitter fight will develop before this measure is passed, although it is an administration bill. These particular interests, which have for years asserted they had preferential rights, will scarcely surrender them now.

Senate Print No. 212, "An act authorizing the superintendent of public works to extend and enlarge the existing state development of water power on and along the canal system of the state and providing for the utilization of the electric current generated therefrom in the operation of canal structures and otherwise, and making an appropriation therefor," is Governor Miller's hydro-electric measure. This bill carries an appropriation of $1,000,000.

The measure directs the superintendent of public works, as soon as practicable, to continue, extend and enlarge the existing plan and system of developing water power on the state canal system for the operation, heating and lighting of locks, bridges and other structures along the canals. Provision is also made for the selection of additional land along the canal system where water power may be developed to advantage, and the superintendent is directed to file with the Governor a description of the sites selected for the work he intends to perform.

The superintendent of public works is authorized to sell to the highest bidder any surplus power not needed by the state.

For the purpose of starting the work under the general plan provided for by this act, $1,000,000 is appropriated for the development and generation into electric energy of water power available at the Crescent and Vischers Ferry dams, on the canalized Mohawk River between the city of Schenectady and the village of Waterford.

This measure will have the backing of the administration. It differs materially from the Democratic measures, from which the construction of the bill is principally taken, in that the administration bill proposes a general plan of development, the state to utilize such power as it may need first and sell its byproduct or overflow to the highest bidder with no restrictions as to resale price, while the Democratic measures contemplate the state's going directly into the project of hydro-electric development for the public benefit with the ultimate end in view of supplying cheap electricity to all the people of the state.

In the article on "Lubrication" published in *Power* Jan. 3, the formula for the aromatic series was, through a typographical error, made to read C_nH_n, when it should be C_nH_{2n-6}.

Heating Engineers Hold Annual Meeting

A number of papers of interest to power-plant engineers were presented at the twenty-eighth annual meeting of the American Society of Heating and Ventilating Engineers.

The sessions were held on Jan. 24, 25 and 26 in the Hotel Pennsylvania, New York City. It was therefore fitting that the first technical paper should be, "Heating, Ventilating and Mechanical Equipment of the Hotel Pennsylvania," by Arthur K. Ohmes. Immediately after this paper, Mr. Ohmes personally conducted the members and guests on a tour of inspection through the hotel, giving them an opportunity to see the equipment that he had described.

This hotel, according to Mr. Ohmes, is the largest in the world, its cubical contents amounting to 18,000,000 cubic feet. The building has a height of 27 stories and contains 27 elevators. It is heated by low-pressure steam with vacuum return lines. In addition, there is an extensive ventilation system, provided with tempering and reheating stacks, as well as air washers.

Alternating current at 11,000 volts is supplied from the power station of the Pennsylvania Railroad in Long Island City, about 4 miles away. For power purposes the high-tension current is stepped down to 170 volts, and is then used for driving three 500-kw. motor-generators. These furnish direct current at 240 volts, which is used for elevators, pumps, ventilating motors, etc. Another set of transformers supplies alternating current at 240 volts for the three-wire lighting systems.

There is a 195-ton refrigeration plant, which includes three 65-ton ammonia compressors driven by Corliss engines, and three brine systems operation at + 15 deg. F., 0 deg. F. and — 7 deg. F. respectively.

Steam is not generated in the hotel building, but is obtained at 140 lb. pressure from the adjoining central heating plant of the Pennsylvania Station. The maximum steam consumption is 90,000 lb. per hr.

As the preliminary calculations showed that a certain amount of exhaust steam could be used throughout the year, a 500-kw. Corliss-engine-driven generator was installed. According to Mr. Ohmes, the hotel saved $19,600 during the winter of 1920-1921 by not using purchased current.

After the inspection trip, W. J. Baldwin, honorary member, gave a paper on "Improvements in the Process for Cleaning and Drying Air Mechanically." In this he described and explained the Baldwin method of washing, drying and conditioning air. The separation is accomplished by combining a fan (the centrifugal element) with a stationary ring to catch the solid particles. A high degree of separation was claimed for this apparatus.

Another paper touching the power field was that of E. N. Fales on "Standardized Method of Measuring Fan Delivery." The method described makes use of a special combination Pitot-venturi tube that is more sensitive than the ordinary Pitot tube. The method was developed primarily to measure the output of enclosed fans, but is said to be applicable to any type of fan. In the discussion, there was some question as to whether the method of testing was sufficiently developed for standardization.

"The Control of Blower Motors," a paper presented by Henry G. Issertell, described and classified the various methods of manual and remote control as applied to constant-speed and variable-speed motors. Both alternating- and direct-current apparatus was considered.

Frank A. DeBoos gave a paper entitled "The Underfeed Stoker," in which he listed the advantages of the underfeed stoker and described most of the types that are well known in power-plant work. The evident aim of this paper was not to give new information on underfeed stokers but to give a broad, simple outline of the subject for the benefit of heating and ventilating engineers.

The following were announced as the new officers of the Society: President, J. R. McColl; first vice-president, H. P. Gant; second vice-president, S. E. Dibble; treasurer, Homer Addams.

Production of Coal in 1921

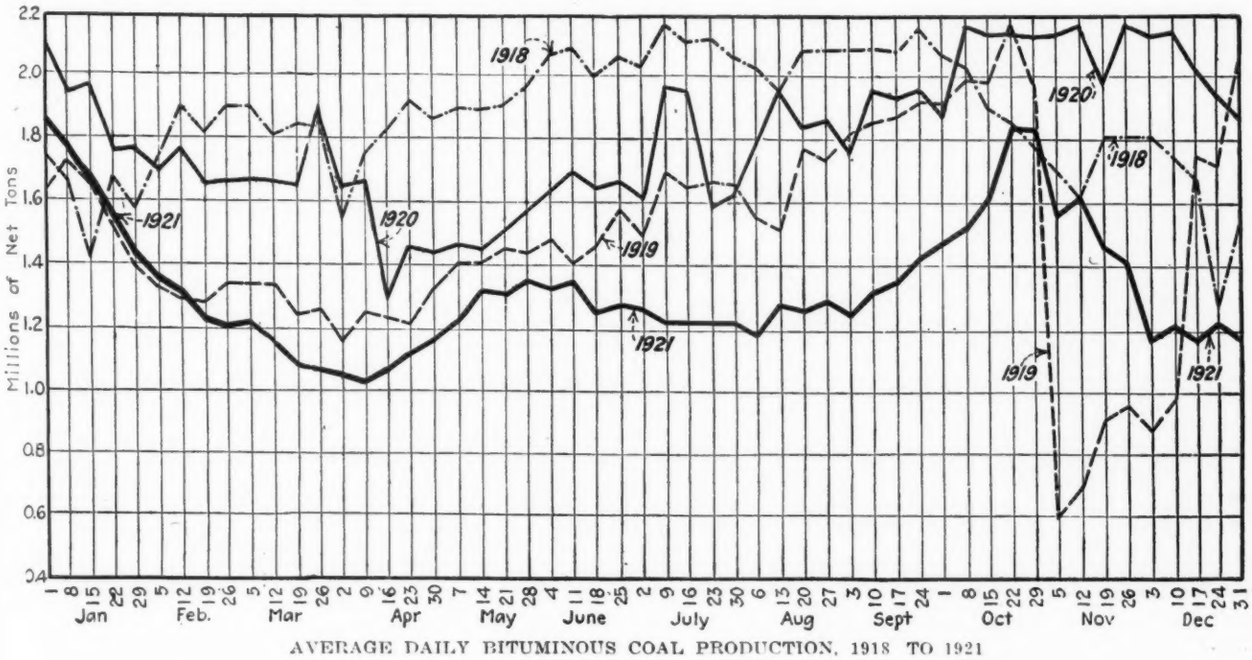
The accompanying chart shows how the daily rates of production of bituminous coal changed from week to week through 1921, and for the sake of comparison gives the figures for the three previous years. It will be noticed that the curve for 1921 is mostly far below all the others. The big drop in production during November, 1919, was due of course to the great strike.

The difference between 1921 and 1920 may be seen also in a comparison between the figures of total production. The total output for 1921 was 407,000,000 tons, while in 1920 it was 556,000,000 tons.

Of course, the low production for the last year was due largely to industrial inactivity, but it is felt that such an explanation does not hold true for the big slump that started at the end of October and has now come down to a low level that has seldom been reached in recent years. The level of production for December, 1921, is lower than that for the same month in the last ten years, with the one exception of the strike year of 1919.

This low rate of production, according to the Geological Survey, is below the rate of consumption, and indicates that consumers are coasting on their stocks instead of buying to meet their current requirements.

The figures given here are for bituminous coal, including coal coked, and are based on reports of the Geological Survey.



AVERAGE DAILY BITUMINOUS COAL PRODUCTION, 1918 TO 1921

Marine Engineers Hold Forty-Seventh Annual Convention

The forty-seventh annual convention of the National Marine Engineers' Beneficial Association was held at Washington, D. C., during the week beginning Monday, Jan. 16, with headquarters at the New Ebbitt Hotel. There were upward of fifty delegates present, representing 149 votes. This small attendance was largely due to the present depression in the maritime commerce of the country.

The several meetings of the delegates were held in the banquet hall of the hotel. The first session was called to order by President Brown at half past nine on Monday morning. The reading of the report on credentials occupied the time until twelve o'clock, when James Davis, Secretary of the Department of Labor, gave an interesting address. The session closed after former National President General Uhler gave the convention a heart-to-heart talk, urging the delegates to "be loyal to the M.E.B.A."

On Thursday afternoon the delegates listened to a brief address by J. E. Burke, managing editor of *American Marine Engineering*.

At the meeting on Friday afternoon the delegates decided, after much discussion, to change the term of the National officers to one year instead of three years, as heretofore.

The keynote of the convention was harmony, and all through the deliberations of the delegates there was a tendency toward the welfare and uplift of the organization. There is to be a drive for increased membership this year, and because of the large number of marine engineers out of employment, many of the delegates favored a temporary lowering of the initiation fee toward this end.

One of the resolutions passed by the delegates provided that all supervising inspectors of the United States Steamboat Inspection Service be placed on the civil service list.

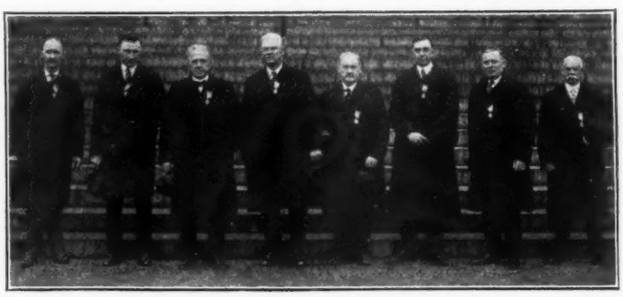
On Saturday, in compliance with the wishes of the membership, the charter of Ocean Lodge, No. 80, of New York City, was revoked for neglect to comply with important provisions of the constitution. This leaves No. 33 the only M.E.B.A. organization in the port of New York.

On Monday, Jan. 23, the National officers, in conjunction with a special committee of the association, appeared before President Harding and the United States Shipping Board for the purpose of having the present wage agreement extended for a period of six months.

On Wednesday, Jan. 18, the delegates and guests were received by President Harding, after which the official photograph was taken. It is reproduced here.

The big feature of the convention was the smoker in the ballroom of the New Willard Hotel on Thursday night, tendered to the M.E.B.A. by the Supplymen. Brierwood pipes, tobacco, cigars and cigarettes were distributed, and an exceptional vaudeville program was enjoyed by the six hundred guests.

On Wednesday evening the ladies were entertained at the New Ebbitt Hotel by the France Packing Company. Dancing followed an appreciated entertainment, and a refreshing punch was served at intervals. On retiring each lady was presented with a box of chocolates. Throughout the week the ladies of the convention were entertained by auto rides, theater parties, and shopping trips.



THE NATIONAL OFFICERS OF THE M.E.B.A.

From left to right they are: David P. McCracken, chairman of local committee; Samuel J. Hogan, conductor; William H. Hyman, second vice-president; William S. Brown, president; George A. Grubb, secretary-treasurer; Charles M. Sheplar and William J. Garrett, of the executive committee; James E. Purdy, chaplain.

On Thursday the Marine Engineers' Supplymen's Association elected officers as follows: Allan Scott, Johns-Manville, Inc., president; George H. Bowen, Vacuum Oil Co., vice president; Robert P. Jones, France Packing Co., secretary-treasurer. Andrew Lauterbach, retiring president, was presented with a traveling bag. Before adjournment, National President Brown, on request, addressed the Supplymen.

DELEGATES AND GUESTS OF THE NATIONAL MARINE ENGINEERS' BENEFICIAL ASSOCIATION AND THE MARINE ENGINEERS' SUPPLYMEN'S ASSOCIATION ASSEMBLED AT WASHINGTON

News in the Field of Power

Congress Taking Up St. Lawrence River Project

The St. Lawrence River report, which was recently submitted to Congress, has been referred by the House to the Committee on Interstate and Foreign Commerce, although the Ways and Means Committee insisted upon handling that part of the report relating to the joint bond issue. An unsuccessful effort was made to put the measure into the hands of the Rivers and Harbors Committee, which is understood to be hostile to it.

A long fight in Congress is expected over the report, chiefly between Middle West and Atlantic Coast interests. It has been said that Eastern men are afraid the proposed waterway would cripple various Atlantic and Gulf ports, while the Middle Westerners see in the canal a cheap haul that may relieve them from high railway charges.

For the present, Congress has to determine the practicability of the project, leaving until later the question of its advisability. Many hearings will probably be held at which engineering and economic experts will testify.

Detroit Societies Affiliate

After several years of discussion in Detroit among members of the various technical societies, the desire for affiliation has finally resulted in the organization of the Associated Technical Societies of Detroit, effective Jan. 1, 1922. The local sections (either city or state) of twelve engineering and technical societies are now comprised in the membership, including the American Society of Civil Engineers, the American Association of Engineers, the American Society of Heating and Ventilating Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, and the American Society of Steel Treating, together with the Detroit Engineering Society and others.

Representatives of each of the member societies form the permanent council, of which the officers for 1922 are: Chairman, P. W. Keating; vice chairman, A. A. Meyer; secretary-treasurer, Walter R. Meier. A central office will be established, in which the business of the several societies will be carried on.

One advantage of this association is expected to be that conflicts between meeting dates will be avoided by having the schedules for meetings worked out by the central office. The association itself will arrange for one meeting a month.

The principal opportunity and object of the new organization, however, lie in the accomplishment of public service, both for Detroit and for Michigan. The association will take an active interest in public affairs, will try to be helpful to city and state officials and will make an effort to provide accurate technical information whenever it is needed for public improvements and undertakings.

Hoover Warns of Coal Strike

"Unless something unforseen occurs to adjust the difficulty, it seems that the stage is set for a strike." This is Secretary Hoover's opinion on the threatened strike of both anthracite and bituminous coal miners when their wage agreement expires at the end of March. The operators, on the other hand, claim to hold the opinion that there will be no strike. The Government has not given up hope of a peaceful settlement, but little progress has yet been made.

The demands of the two sides are far apart. The operators maintain that if they cannot cut wages April 1 they must either operate at a loss or close down their mines. They point out that they must meet the competition of the non-union mines, where wages have been lowered. The miners, on the other hand, say that they cannot live on the existing rate; the anthracite workers demand a 20 per cent raise, the "check-off," extra overtime rates and the universal eight-hour day, and the bituminous workers are not far behind.

In the event of a strike, coal will of course be scarce, but there will be enough of it to keep basic industries from being crippled, it is believed. Present bituminous consumption is near to 7,000,000 tons a week, and it has been estimated that the West Virginia and other non-union fields could turn out from 4,000,000 to 5,000,000 tons a week, regardless of the strike.

Ford Signs Muscle Shoals Contract

HENRY FORD has signed the official contract comprising his offer for Muscle Shoals. The next move is up to Congress, which alone has authority to close the deal. The "Second Niagara" is nearing realization.

Filter Manufacturers to Meet in Philadelphia

The Association of Manufacturers of Water Purifying Equipment plan to hold their annual meeting at the Bellevue-Stratford Hotel, Philadelphia, Pa., on Feb. 7. It is understood that the association includes in its membership practically all manufacturers of water-purification apparatus.

The most important business that will come up will be the adoption of standard specification requirements for pressure filters for various purposes.

President Cooley of F. A. E. S. to Swing Around the Circle

President Mortimer E. Cooley, of the Federated American Engineering Societies, is to carry the message of the Federation to the engineers of the South and Middle West in a five weeks' trip starting Feb. 5 from Ann Arbor, Mich., and ending March 10 in Chicago. He will make about twenty speeches before technical and engineering organizations and before various universities. Among the cities he will visit are Kansas City, Topeka, Oklahoma City, Dallas, Houston, New Orleans, Atlanta and Nashville.

Kimball and Stratton Speak at Chicago before A.S.M.E.

At a meeting of the Chicago section of the American Society of Mechanical Engineers, held Jan. 20, in the Hotel Sherman, speeches were heard from the new president of the Society, Professor Dexter S. Kimball, Dean of the College of Engineering at Cornell, and Dr. S. W. Stratton, director of the United States Bureau of Standards.

President Kimball discussed the problems and opportunities before the engineers of today, emphasizing the need of a broader interpretation of engineering to meet the increasing complexities of modern civilization. He pointed out that the engineer is no longer simply a technical man, but has entered the field of management, and has broadened the scope of his work far beyond the original conception of the profession. He explained that the field of management is divided into three branches, production, economics and human relations. In handling production, of course, the engineer finds little difficulty. But in the study and application of the principles of economics and human relations, Dean Kimball held that engineers should make greater efforts to perfect themselves. He took the position that this is the logical course of development for engineers to follow, if they are to keep up with the times. Broadening this thought, he pointed out the possibility for engineers to accomplish great things in national affairs through organization and through the grouping together of their various associations.

Dr. Stratton outlined the large amount and the great variety of the work of the Bureau of Standards, giving his hearers a new understanding of the experiments and research that must be carried on to maintain the standards of weights, measures, etc., with which they had felt so familiar. The speaker told also about the men who worked with him in the Bureau, and of their many problems in physics, engineering and chemistry.

Safety Census Being Taken

The rising importance of safety work is well shown by the fact that a census of all those engaged in any form of industrial or public safety work, or industrial health work, is being undertaken by the National Safety Council. The aim is to make this census include not only members and employees of members of the Council, but also all others who are doing safety work but who may or may not be connected with the Council.

In putting the plan into effect, a questionnaire is being sent out in which safety workers are being asked about the work of their companies and about their positions and the definite ways in which they are responsible for safety, as well as their experience and education.

The Council, which has offices at 168 North Michigan Ave., Chicago, is devoting every effort at present to making this census complete and accurate, and is requesting everyone who is in any way connected with safety work, whether he gives all or part of his time to it, to co-operate in the work by asking for a questionnaire and filling it out.

New Publications

The Life of George Westinghouse. By H. G. Prout. Published by Chas. Scribner's Sons, New York, 1922. Cloth; 6 x 9 in.; 375 pages. Price, $2.50.

Unlike the biography of many great men, that of George Westinghouse reveals no dual personalities—his pleasures, pastimes, hobbies and work were one—and through it we read a history of successful application in the field of mechanic arts. An inventor by instinct, as is attested by the record of a patent a month for eleven years and one every six weeks for forty-eight years, nevertheless, his greatest contribution to mankind is to be found in that vision and commercial instinct which made possible the transformation of scientific studies into practical equipment which advanced industry and transportation many years. In this work he was ever ready to avail himself of the services of trained experts to whose technical knowledge he supplied creative imagination and the necessary driving force. Never conceding defeat, his optimism and indomitable will overcame almost insurmountable obstacles and turned many apparent failures into success.

Endowed through heritage with a strong physique and mentality, George Westinghouse began his mechanical activities in his father's shop at the age of thirteen and for forty-nine years applied himself unceasingly to his work. His early years were directed to the development of the air brake. That he was not the first to conceive the idea of braking trains by means of air mattered little; it was through his perseverance and the ingenuity of his patents that successful application was brought about and a great service thereby rendered to the field of transportation.

Likewise, in the electrical field his greatest achievement was to hasten the use of alternating current. His vision perceived that it was a solution to the transmission of electricity over great distances, and he was therefore quick to take up and carry through the development of the transformer and the induction motor, acquiring exclusive rights to the latter under the Tesla patents. His faith in alternating current never faltered even in the face of adverse opinions from noted authorities of that day.

Again, recognizing in the steam turbine the solution to large centralized generation of power, he early secured rights under the Parson's patents, which he further developed and brought out the single-double flow principle.

Few men had greater capacity for work and for carrying on simultaneously such a multitude of enterprises. His faith in these was attested by large personal investments and the fact that he never invested outside these undertakings. This, together with the confidence of co-investors, enabled him to keep personal control of these companies for many years; in fact, until the panic of 1908, at which time outside financial interests gained control in some of these enterprises.

As might be expected, Westinghouse occasionally directed his genius toward unattainable goals; among these may be mentioned an effort to reduce the resistance of ships by lubricating the hull and propellers with air, efforts to produce power from the heat of the atmosphere, and his early attention to the rotary engine. The tenacity with which he held to these ideas, sometimes against the advice of trusted advisers, may be ascribed to a lack of fundamental technical training. However, in most cases he was ever ready to recognize new tendencies in engineering progress and to redirect his efforts along these lines; for instance, when he turned his attention from the gas producer and gas engine to the steam turbine.

The American Society of Mechanical Engineers, at whose instance the biography was prepared, was indeed fortunate to secure the services of Colonel Prout, whose long association with Westinghouse, supplemented by a background of editorial experience, has resulted in a most fascinating presentation.

Personals

W. H. Patterson, who has been associated with the Westinghouse company at East Pittsburgh, Pa., for the last sixteen years, has resigned to become vice president of the Kaestner and Hecht Co., electric elevator builders, Chicago.

C. H. Davies has left the S. F. Bowser Pump and Tank Co., with which he had been associated for 16 years in sales and publicity work. He has taken charge of advertising and marketing with the Citrus Products Co., of Chicago.

O. M. Rau, formerly consulting engineer with the Philadelphia Rapid Transit Co., is now with the Hardinge Co., Inc., 120 Broadway, New York City, specializing in the handling of Quigley pulverized fuel systems as applied to boilers. The Quigley Company's pulverized fuel business was taken over some time ago by the Hardinge Company.

Society Affairs

Coming Conventions

American Institute of Electrical Engineers—Midwinter convention at New York City, Feb. 15-17. Secy., F. L. Hutchinson, 29 West 39th St., New York City.

American Society of Mechanical Engineers — Spring meeting at Atlanta, Ga., May 8-11. Secy., Calvin W. Rice, 29 West 39th St., New York City.

National Electric Light Association —Annual convention at Atlantic City, N. J., May 15-20. Headquarters, 29 West 39th St., New York City.

Baltimore Section, A.S.M.E., will meet Feb. 8 for a talk by Dr. Charles R. Mann on "Vocational Education."

The Engineers of Boston will hold their annual dinner Feb. 7 in the City Club. Philip Cabot and President Lowell will speak.

Cleveland Section, A.S.M.E., will hear a lecture on "Fuels" by Dr. R. H. Fernald, of Philadelphia, at the Hotel Winton, on Feb. 7.

Toronto Section, A.I.E.E., will meet Feb. 10 in the Electrical Building, Toronto University, to hear F. M. Farmer, of the Canadian Westinghouse Co., speak on "Construction Work."

Cincinnati Section, A.I.E.E., is to meet Feb. 8 in the auditorium of the University of Cincinnati. R. Sanford Riley will discuss combustion, with especial reference to stokers, and will show his moving pictures of stoker operation.

Philadelphia Section, A.I.S.E.E., is to meet Feb. 4 for a talk by W. W. Pettibone, assistant chief engineer of the Bethlehem Steel Co.'s Lebanon plant, on "Efficient Burning of Fuel and Use of Waste Gases in the Industrial Plant."

Brooklyn (N. Y.) Combined Associations of the N.A.S.E., will hold their entertainment and ball on Friday, Feb. 3, at the Masonic Temple, corner Clermont and Lafayette Avenues. The Associations comprise Nos. 8, 27, 41 and 57. Tickets may be obtained from John P. Martin, 1078 Prospect Place, Brooklyn.

Business Items

The Whitlock Coil Pipe Co., Hartford, Conn., has announced that D. B. Van Tassel is to handle its superheater business in Detroit and vicinity.

The Gifford-Wood Co., Hudson, N. Y., has transferred James E. Moul from the position of manager of the Buffalo office to the same position in the New York office.

The C. H. Wheeler Manufacturing Co., Boston, Mass., has appointed H. W. Cross as district manager. He was formerly turbine specialist with the G.E. company.

H. Goodwin, Jr., and E. M. Newlin have formed a partnership under the name of Goodwin, Newlin & Co. They will conduct a general business in investment securities, dealing particularly with those of H. M. Byllesby & Co., Inc.

Barber-Greene Co., Aurora, Ill., has appointed D. B. Frisbie, with offices at 90½ North Forsythe Street, Atlanta, Ga., to develop a selling organization throughout the South for the company's line of belt conveyors and bucket loaders.

The Heine Boiler Co. has passed into the control of C. R. D. Meier, who has been president of the company since 1918 and whose father founded the concern, through a decree of the Circuit Court in St. Louis. After many years of litigation, Mr. Meier has succeeded in buying up all claims against the company, thus ending a dispute of long standing between numerous heirs, executors and trustees who have been involved in a complex series of lawsuits. The stock involved in the transaction is said to be between 60 and 70 per cent of the total issued by the company.

Trade Catalogs

Electric Equipment—Walker Electric and Plumbing Co., Atlanta, Ga. An attractively prepared bulletin comprising installation photographs and a general discussion of the electrification of cotton mills and the installation of electrical equipment in industrial plants, villages, homes, etc.

Automatic Combustion Control—Automatic Fuel Saving Co., 549 West Washington Blvd., Chicago, Ill. A discussion of the need for automatic control of boiler furnaces, giving the principles involved and explaining the Gray system of automatic control for the boiler damper, air supply and stroker feed.

Circuit Breakers—**The Cutter Co.,** Philadelphia, Pa. A description of the U-Re-Light circuit breaker, which is inclosed in a steel box and may be adjusted for different currents and readily closed after being opened by an overload. It is for d.c. or single-phase a.c. use up to 250 volts, 200 amperes.

Recording Instruments—Esterline-Angus Co., Indianapolis, Ind. A short bulletin, No. 122, chiefly on the use of portable watt-meters in checking up manufacturing operations. Additional literature is offered in which the electrical engineer of a manufacturing plant tells how he saved $24,000 a year with graphic records.

Hytempite in the Power Plant—Quigley Furnace Specialties Co., 26 Cortlandt St., New York City. An unusually interesting booklet on the uses of Hytempite refractory material for bonding firebrick and for similar purposes. This material is used also in making concrete baffles, as described in *Power* for October 25.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	Jan. 16, 1922	Jan. 23, 1922
Pool 1,	New York	$3.00	$2.85@3.50
Pocahontas,	Columbus	2.15	2.00@2.25
Clearfield,	Boston	2.05	1.65@2.25
Somerset,	Boston	1.80	1.60@2.00
Pittsburgh,	Pittsburgh	2.15	2.10@2.20
Kanawha,	Columbus	1.80	1.50@1.85
Hocking,	Columbus	1.85	1.75@2.00
Pittsburgh No. 8	Cleveland	2.10	1.85@1.95
Franklin, Ill.,	Chicago	2.80	2.25@2.50
Central, Ill.,	Chicago	2.50	2.25@2.50
Ind. 4th Vein,	Chicago	2.55	2.40@2.65
Standard,	St. Louis	1.90	1.85@2.00
West Ky.,	Louisville	1.75	1.60@2.00
Big Seam,	Birmingham	2.10	1.90@2.30
S. E. Ky.,	Louisville	1.55	1.50@1.65

New York—On Jan. 25, Port Arthur light oil 22@25 deg. Baumé 4½c. per gal. 30@35 deg., 5½c. per gal., f.o.b. Bayonne, N. J.

Chicago—Jan. 21, for 24@28 deg. Baumé, 80@85c. per bbl.; 32@36 deg., 2⅝@2⅝c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh — On Jan. 10, f.o.b. refinery, Pennsylvania, 36@40 deg., 4½c. Oklahoma 24@30 deg., 85@90c. per bbl.; gas oil, 32@34 deg., 2½c. per gal.; 36@38 deg., 2⅝c., 38@40 deg., 3¼c. per gal.

St. Louis—Jan. 21, prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 75c. per bbl.; 26@28 deg., 85c.; 28@30 deg., $1.; 32@34 deg., 2½c. per gal.

Philadelphia—On Jan. 25, 26@28 deg. Baumé, Oklahoma, 80@85c. per bbl.; 30@34 deg., Oklahoma (group 3) 2¼@2⅜c. per gal.; 16@20 deg., Seaboard, $1.15@$1.25 per bbl.

Cincinnati—Jan. 23, for 26@30 deg. Baumé, 3⅜c.; Diesel 32@34 deg., 4¼c. per gal.; distillate 38@42 deg., 5c. per gal.

Cleveland — Jan. 23, 26@30 deg. Baumé, 2¾c. per gal.

New Plant Construction

PROPOSED WORK

Cal., Los Angeles—Morgan, Walk & Morgan, archts., 1124 Van Nuys Bldg., will receive bids about Feb. 1 for a 4 story, 50 x 120 ft. and two 2 story, 40 x 120 and 40 x 170 ft. hospital buildings, including a steam heating system on Boyle Ave. for the Hollenbeck Home. About $300,000.

Cal., Los Angeles—L. Schultze and S. F. Weaver, Archts., 17 East 49th St., New York, will soon receive bids for a 12 story hotel on 5th and Olive Sts. here. About $10,000,000. H. Balcom, 10 East 47th St., New York, Engr. Owner's name withheld.

Cal., Los Angeles — The Sun Drug Co., c/o A. E. Curlett, Archt., 518 Merchants Bank Bldg., is having plans prepared for a 12 story, 66 x 88 ft. store and loft building on 7th and Hill Sts. About $500,000.

Cal., Long Beach—The Park View Land Co. is having plans prepared for a 12 story, 134 x 136 ft. hotel, including a steam heating system on Ocean Ave. About $800,000. L. L. Smith, 804 Higgins Bldg., Los Angeles, Archt.

Cal., Madera—The city will receive bids until Feb. 6 for a 75 hp. motor turbine pumping plant, 950 gal. per min. F. Nikirk, City Engr.

Cal., Newport Beach — The Newport Heights Irrigation Dist. receives bids about Feb. 1st for construction of a water plant, including reservoir, pumping station and distribution system. P. Kressby, H. W. Hellman Bldg., Los Angeles, Engr.

Conn., New Haven—D. E. Smith, Archt., 152 Temple St., is preparing plans for a 1 story, 160 x 200 ft factory and a 1 story, 40 x 50 ft. boiler plant. Owner's name withheld.

Conn., Stratford (Bridgeport P. O.)—Hollander Bros., 360 George St., Bridgeport, having plans prepared for a 3 story, 55 x 104 ft. metal goods factory and a 1 story boiler house on Seymour St., here. About $50,000. Davis & Dane, 1024 Main St., Bridgeport, Archts.

Fla., Clearwater—The city plans election Feb. 21 to vote $40,000 bonds for extending water mains and installing new pumping equipment. About $40,000.

Fla., Lakeland — The Southern College will receive bids until Feb. 7 for three college buildings, including a steam heating system. About $300,000. F. H. Trimber, Orlando, Archt.

Fla., Orlando—The city plans election $150,000 bonds for an addition to power plant.

Ga., Augusta—The Treasury Dept., J. A. Wetmore, Supervising Archt., Wash., D. C., received bids for mechanical equipment in the United States Public Health Service Hospital here from Noland-Clifford Co., Inc., 330 28th St., Newport News, Va., $134,963; W. G. Cornell Co., 19 Patterson St., N. E., Washington, D. C., $146,600; and C. F. Mentzinger's Sons, 354 Bway., Brooklyn, N. Y., $148,683. Noted Jan. 3.

Ill., Chicago—E. Benson and J. Marling, c/o Michaelsen & Rognstad, Archts., 3815 West Congress St., is having plans prepared for a 5 story, 240 x 249 ft. bank, store and office building, including a steam heating system, on Milwaukee Ave. and Irving Park Blvd. About $400,000.

Ill., Chicago — A. S. Hecht, Archt., 225 East Erie St., is receiving bids for a 7 story, 50 x 107 ft. apartment hotel, including a steam heating system, at 647-49 Sheridan Rd., for J. Vehon, 651 Sheridan Rd. About $400,000.

Ill., Chicago—J. H. Optner, c/o D. S. Klafter, Archt., 64 West Randolph St., is having plans prepared for a 5 story, 100 x 125 ft. store and office building including a steam heating system on 69th St. and Halsted Ave. About $250,000.

Ill., Evanston — V. C. Carlson, Archt., Evanston, is preparing plans for a 7 story, 120 x 211 ft. apartment hotel, including a steam heating system, on Orrington Ave. and Church St. About $1,500,000. Owner's name withheld.

Ill., Oak Park—T. R. Bishop, Archt., 35 South Dearborn St., Chicago, is receiving bids for a 3 story, 28 x 180 ft. apartment including a steam heating system on Pleasant Ave. and Wisconsin St., here, for H. J. Kusel, 35 South Dearborn St., Chicago. About $500,000.

Ill., Rockford—The Bd. Educ., E. F. Lewis, Supt., will receive bids until Feb. 9 for a 3 story junior high school, including a steam heating system, on Hockell Ave. About $650,000. Peterson & Johnson, Swedish American Bank Bldg., Archts. Noted Aug. 9.

Ill., Rockford—The Roman Catholic Diocese of Rockford, P. J. Muldoon, Bishop, 1704 National Ave., plans to build a cathedral and home. About $1,500,000. Architect not selected.

Ill., Rockford—C. E. Wolfley, Archt., 610 Stewart Bldg., will receive bids until Feb. 3 for a 1 story, 60 x 145 garage, 35 x 60 ft. repair shop, and 20 x 30 ft. boiler plant on Auburn Ave., for G. C. Brown and W. C. Gridley, 1826 Hoffman Blvd. About $75,000. Noted Dec. 27.

Ind., Crown Point—The Bd. of County Comrs. plans to build a sanitarium, theatre and power plant. About $400,000. J. N. Coleman, 3251 St. Lawrence Ave., Chicago, Ill., Archt.

Ind., Indianapolis — The Indianapolis Light & Heat Co., Monument Pl., is having plans prepared for a 1 story, 63 x 90 ft. turbine building on West and Kentucky Aves. About $42,000. Private plans.

Ky., Bowling Green—The city will receive bids until Feb. 6 for machinery and equipment for pumping station, including two, 200 hp. oil engines, direct connected to 175 K.V.A. 440 volt, 3 phase, 60 cycle alternators with exciters, two, 200 hp. steam turbine driven sets and two deep well, motor driven pumps. H. E. Stone, Mayor.

La., Baton Rouge—The state is having sketches made by Ormsted Bros., Archts., Brookline, Mass. and Walker & Gillette, Assd. Archts., 1286 37th St., New York City, for an agricultural college to be known as the Greater Agricultural College of Louisiana. Total cost, about $10,000,000.

La., New Orleans—The Sewerage and Water Bd., Room 401, 526 Carondelet St., will receive bids until Mar. 20 for 1,500 to 1,800 hp. boilers, centrifugal pumps and electric machinery. Former bids rejected. Noted Nov. 8.

La., New Roads—The town plans to remodel electric light and water plant and install crude oil engine driven alternators, pumps, reservoir, etc. J. L. Swanson, Pres.

Mass., Boston—The Beacon Trust Co., 20 Milk St., is having plans prepared for a 12 story, 40 x 138 ft. office building on Milk St. About $1,000,000. A. H. Bowditch, 44 Brownfield St., Archt.

Mass., Gardner — The Memorial Bldg. Comn., R. N. Wiley, Chn., will receive bids until Feb. 6 for a 3 story, 170 x 252 ft. town hall, including a steam heating system, on West Gardner St. About $350,000. P. Varney, 25 Exchange St., Lynn, Archt.

Mass., Quincy—The city will soon award the contract for a 3 and 4 story, 252 x 330 ft. high school on Coddington St. About $750,000. Crane & Ferguson, 248 Boylston St., Boston, Archts.

Mich., Detroit—The Health Bd., 1415 St. Antione St., having plans prepared for first unit of a 4 story hospital, including a steam heating system, on 12th St. Total cost about $3,000,000. A. Kahn, 1000 Marquette Bldg., Archt.

Mich., Detroit—The University of Detroit, 630 East Jefferson Ave., plans to build a 2 story, 200 x 275 ft. gymnasium including a steam heating system on Livernois Ave. About $300,000. Architect not announced.

Mich., Northville—The Detroit House of Correction, Russell and Alfred Sts., plans to build a prison institution including a steam heating power plant in Plymouth Twp. About $2,500,000. Architect not selected.

Minn., Ada—The city, J. O. Lindahl, Secy. Light Bd., is having surveys made for rebuilding distribution system and connect with high line or building new power plant. Cost from $16,000 to $40,000. C. L. Pillsbury Co., 1200 2nd Ave., S. Minneapolis, Engrs.

Minn., Minneapolis—The State Bd. of Control, D. F. Mullen, Secy. the Capitol, St. Paul, plans to build a 3 story electrical engineering building including a steam heating system at the State University. About $300,000. C. H. Johnston, 715 Capital Bank Bldg., St. Paul, Archt. C. L. Pillsbury Co., 1200 2nd Avenue. South, Engrs.

Minn., Newport—The Farmers Terminal Packing Co., 920 Commerce Bldg., St. Paul, is having plans prepared for a 1 story, 100 x 100 ft. ice plant near here. About $60,000. Newstrom-Lindquist Co., 810 Lumber Exchange, Minneapolis, Archts.

Mo., Jefferson City—The Lincoln University, C. H. Kirshner, Pres., is having plans prepared for 4-3 story college buildings including a steam heating system. About $500,000. E. C. Janssen, Chemical Bldg., St. Louis, Archt.

Mo., St. Louis—The Sisters of St. Mary, 1536 Papin St., will soon award the contract for a 7 story, 160 x 280 ft. hospital including a steam heating system on Belleview St. and Clayton Rd. About $1,000,000. A. B. Groves, Stock Exchange Bldg., Archt. Noted July 19.

Mont, Bozeman—The State University of Montana, Bd. of Examiners, Helena, will receive bids until Feb. 11 for a 1 story, 45 x 74 ft. heating plant, and equipment, including water tube boilers, stokers, pumping equipment, coal and ash handling equipment, chimney, etc. About $150,000. F. Wilson, Bozeman, Archt., C. L. Pillsbury Co., 1200 2nd Ave., Minneapolis, Minn., Engrs. Noted Nov. 1.

Mont., Missoula—The State University of Montana, Bd. of Examiners, Helena, will receive bids until Feb. 11 for a 1 story, 45 x 74 ft. building and equipment including water tube boilers, stokers, pumping equipment, coal and ash handling equipment, chimney, etc. About $150,000. O. Bakke, Gibson Bldg., Archt. C. L. Pillsbury Co., 1200 2nd Ave., Minneapolis, Minn., Engrs. Noted Nov. 1.

N. J., Trenton—The Y. W. C. A., 138 East Hanover St., plans to build a Y. W. C. A. on East Hanover St. About $600,000. E. W. Dunham, 365 West State St., Pres.

N. Y., Buffalo—The Terrain Realty Co., 206 Bway., is having plans prepared for a 15 story, 51 x 131 ft. office building on Paul and Seneca Sts. About $700,000. Esenwein & Johnson, Ellicott Sq., Archts.

N. Y., New York—The Bd. Educ., Municipal Bldg., will receive bids until Feb. 3 for installing heating and ventilating apparatus and temperature regulation apparatus, etc., in P. S. 189 on Amsterdam Ave. between 188th and 189th Sts.

N. Y., New York—H. Claman, 241 West 43rd St., is having sketches made for a 15 story hotel on 8th Ave. and 43rd St. Private plans.

N. Y., Rochester—The Bd. Educ. has had preliminary plans prepared for a 3 story, 346 x 450 ft. high school with a 100 x 100 ft. wing on Hudson Ave. and Morton St. About $4,000,000. E. S. Gordon, 125 Sibley Block, Archt.

N. C., Enfield — The city plans electric lighting system. About $50,000. J. L. Burrows, Clk.

O., Cleveland — T. C. Minor, Archt., Wade-Chatteau Apt., is receiving bids for a 4 story, 56 x 256 ft. apartment, including a steam heating system, at 7338 Euclid Ave. for the Euclid Carnegie Co., c/o Archt. About $300,000.

O., Cleveland—The Union Trust Co., c/o M. S. Halliday, 1128 Citizens Bldg., will receive bids about Feb. 20 for a 20 story, 145 x 258 ft. bank and office building, including a steam power plant, on East 9th St. and Euclid Ave. About $10,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., Chicago, Ill., Archts. Noted June 21.

O., Columbus—The Bd. Educ., E. McCune, Clk., will receive bids about Feb. 15 for a 2 story, 220 x 300 ft. high school. About $850,000. R. McCarty & Bulford, 384 East Broad St., Archts.

O., Columbus—The city plans to build a dam 70 ft. high 1,400 ft. long on the Scioto River. Arrangements will be made to develop water power later on if desired. Cost about $3,000,000. C. B. Hoover, Supt.

O., Oberlin—The Oberlin College plans to build a group of college buildings including a power plant and storage building. Total cost about $8,000,000. C. Gilbert, 244 Madison Ave., New York, Archt. A. Dufty, 32 East College St., Resident Engr.

Okla., Vinita—The city is having surveys made for a transmission line, pumping station, filtration system and settling basins. About $350,000. Burns & McDonnell Engr. Co., Interstate Bldg., Kansas City, Mo., Engrs.

Pa., McKeesport—The Bd. Educ. plans to build an addition to high school on 10th St. About $300,000. T. B. and L. Wolfe, Century Bldg., Pittsburgh, Archts. Noted Nov. 29.

Pa., Oakmont—The School District of Haverford Twp., c/o J. W. Huff, 6035 Lansdowne Ave., Phila., is having plans prepared for a 3 story high school in Delaware County. About $300,000. Boyd, Abel & Gurget, 112 South 16th St., Phila., Archts.

Pa., Phila.—A. M. Greenfield & Co., 15 and Chestnut Sts., is having preliminary plans prepared for an 18 story, 80 x 140 ft. office and store building, and power plant. About $1,600,000. Hoffman Henon Co., Finance Bldg., Archts.

Pa., Williamsport—H. A. Moore, 114 Elm St., Milton, plans to build a 2 story, 50 x 120 ft. power plant, warehouse and building supply shops, on Franklin and 4th Sts. About $85,000.

S. D., Watertown—The Pub. Utilities Comn., G. K. Burt, Secy., will receive bids until Feb. 16 for an electric distribution system.

Tenn., Johnson City—The Doe River Sand Co., R. Nelson Campbell, Pres., 208 East Main St., is in the market for a 10 to 12 hp. portable steam boiler and engine.

Tex., Vernon—The city plans a bond issue of $100,000 for the construction of an electric light plant.

Va., Wytheville—R. P. Johnson, manufacturer of machinery, O. M. Johnson, Purch. Agt., is in the market for one 16 hp. D.C. D.D. hoisting engine with boiler and with boom swinging attachment, and one 10 to 12 ton ice plant, complete with boiler.

Wis., Fond-du-Lac—The Wisconsin Hotel Co., 29 South Main St., will soon award the contract for an 8 story hotel (Palmer House), including a steam heating system. About $400,000. N. S. Spencer & Son, 37 West Van Buren St., Chicago, Ill., Archts. Noted Nov. 29.

Wis., Lake Mills—The village plans to install a pumping engine in its pumping station here. N. H. Talk, City Clk.

Ont., Ottawa—The Ottawa Collegiate Bd., G. Bowie, Chn., 7 Monkland Ave., will receive bids until Feb. 6 for a 3 story collegiate on 1st Ave. About $700,000. Vacuum steam heat with mechanical ventilation will be installed. J. A. Ewart, Jackson Bldg., Archt. Noted Oct. 4.

CONTRACTS AWARDED

Cal., Sacramento—The City Comn. has awarded the contract for installing pumping equipment in Sewage Pumping Station No. 1 to Latourette-Fical Co., 3431 Sacramento Blvd., $10,500. Noted Jan. 10.

Ind., Marion—The city has awarded the contract for alterations to pumping station and installing a 5,000,000 gal. steam pump to C. W. Bailey, Marion. About $50,000. Noted Dec. 6.

Kan., Hoxie—The city has awarded the contract for the construction of a waterworks system including 40,000 gal. tank, 100 ft. tower, two deep well pumps, etc., to Reed & Wheelock, Clay Center, $31,067.63.

N. Y., New York—The Lucania Realty Co., c/o C. Candela, Archt. and Engr., 200 West 72nd St., will build a 15 story apartment at 2480 Bway. About $1,500,000. Owner will build by separate contracts.

N. Y., New York—Prisanent Bros., c/o Sugarman & Hess, Archts., 17 E. 49th St., New York City, has awarded the contract for a 15 story hotel on 74th St. between Bway. and Amsterdam Ave. to J. G. Siegel, 17 East 49th St.

Pa., Phila.—The city has awarded the contract for piping for Queens Lane and Larners Port Pumping station to W. K. Mitchell & Co., 2940 Ellsworth St., $11,833.11; foundations for Belmont Pumping station to Mitchell Houseworth Co., 30th and Lehigh Ave., $21,747; furnishing steel connecting flues and economizers to The Phila. Tank & Stack Wks., Phila., $7,388. Noted Jan. 17.

Pa., Phila.—J. T. Lewis & Bro. Co., Lafayette Bldg., has awarded the contract for a 2 story, 60 x 70 ft. power house to the Turner Constr. Co., 1713 Sansom St. About $100,000.

Pa., Phila.—The Presbyterian Hospital has awarded the contract for a 5 story, 80 x 201 ft. hospital on Powelton and Saunders Aves. to the Wark Co., 231 South Broad St., $400,000. A steam heating system will be installed.

Tenn., Memphis — The State Bd. Educ. has awarded the contract for a 3 story, 43 x 168 ft. dormitory building at the Normal School at West Tennessee, to F. B. Young, Bank of Commerce Bldg., $107,241; power and heating plant to Hull & Co., Memphis.